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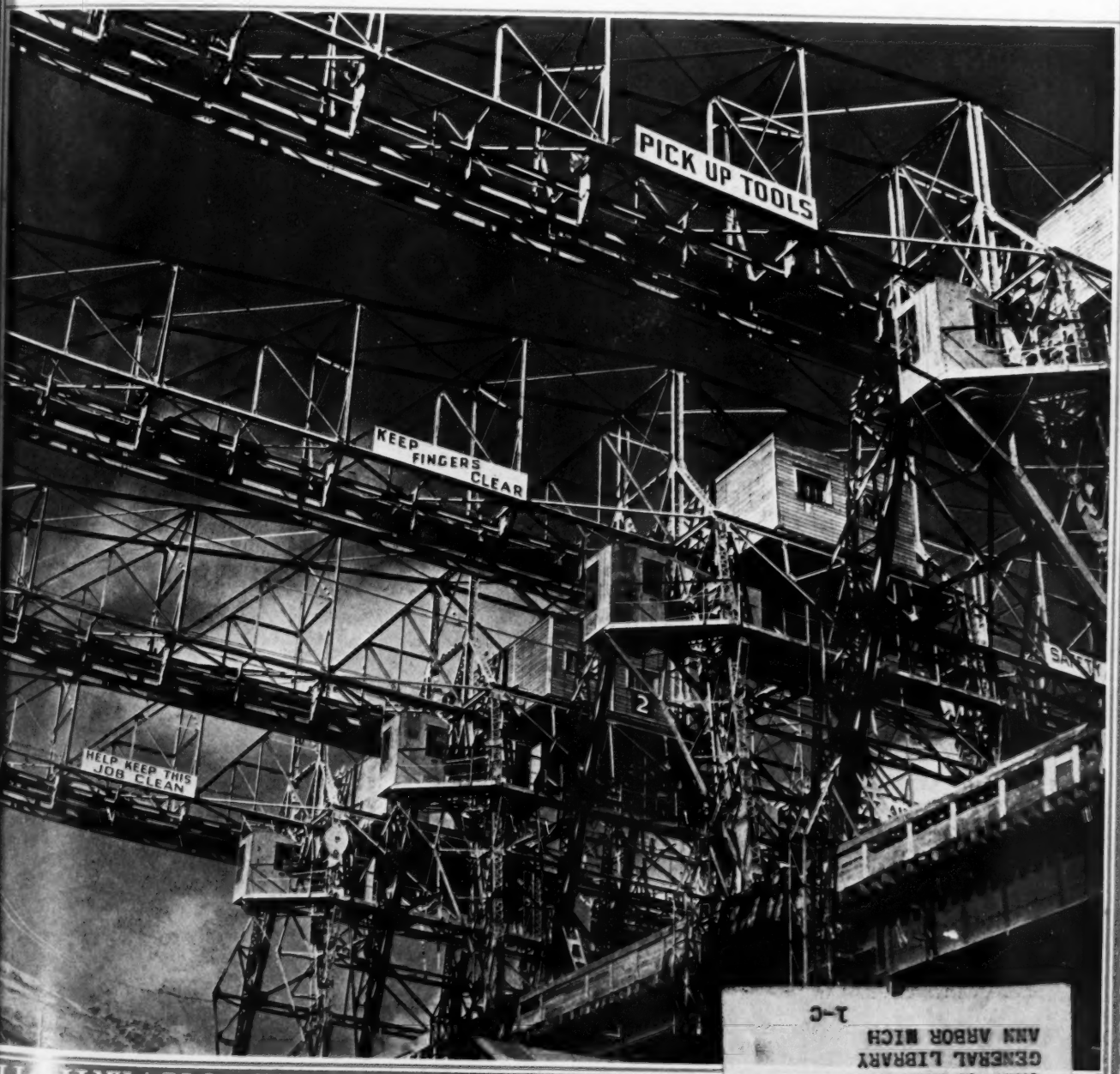
June 16, 1938

Hammerhead cranes at rest between contracts at Grand Coulee



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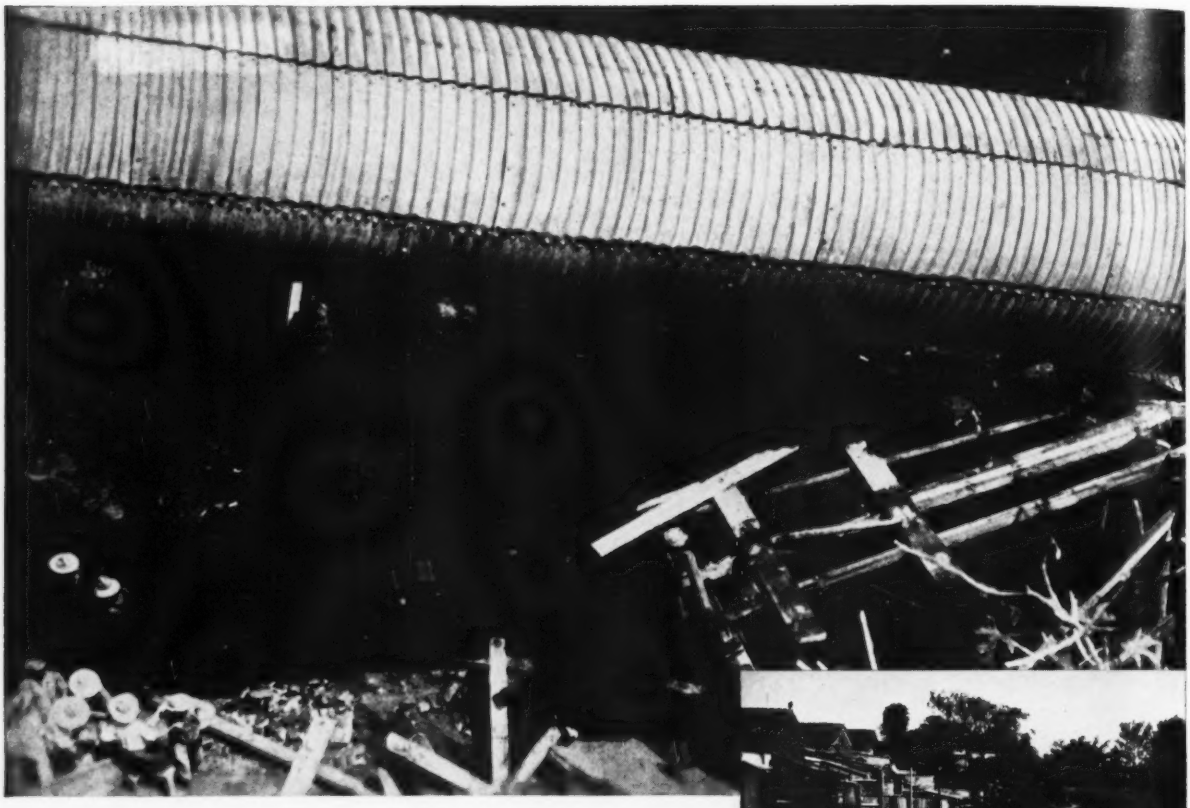

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Vol. 120 *JUNE 16, 1938* No. 24

THIS WEEK AND NEXT

CONFLICTING opinion concerning the reason for warping and heaving of concrete slabs on clay subgrade may be cleared up by the results of field laboratory investigations being made on a test road in Texas.

A second article on Texas roads tells how test sections are demonstrating the advantages of proper control of drainage from the roadbed.

How a ½-yd. crane with a boom extended to a greater length than it could handle unaided climbed to the first story of a building and was used to erect 35-ft. columns surmounted by high roof trusses is told on page 845.

The irregular fuel value of raw garbage and rubbish has long been a sore spot in incineration, especially in its relation to power production. In New York, experiments are being made which may result in better combustion control through use of shredded refuse and furnace feeding devices.

In some places it is necessary to build earth dams with material lacking in cohesion. Such is the case at the site of a proposed dam for Merrimack River flood control, where sand and silt are the principal available materials. Richards M. Strohl describes field tests of compaction methods proposed to meet this situation.

Structural tests on Douglas Fir plywood were undertaken recently at Stanford University. Harry A. Williams of the Civil Engineering Department there describes methods and results of tests run.

NEXT WEEK — Stabilization of pavement bases with cement is one of the most important developments in highway design in recent years. Next week the first of two articles by recognized authorities on this subject will be published.

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THE COVER PICTURE shows Hammerhead cranes at Coulee Dam ready to carry on the work of placing concrete in the second stage of construction which will carry the dam to the 550-ft. mark. Each crane bears a reminder of the everpresent need for safety precautions on any construction job.

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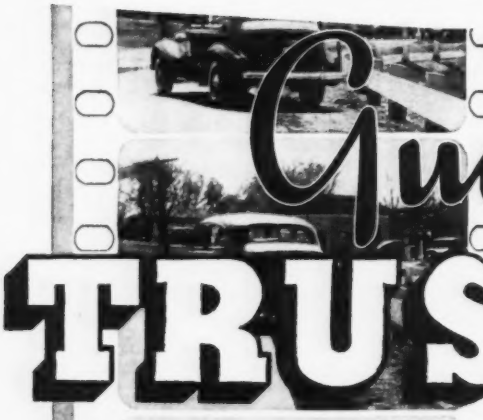

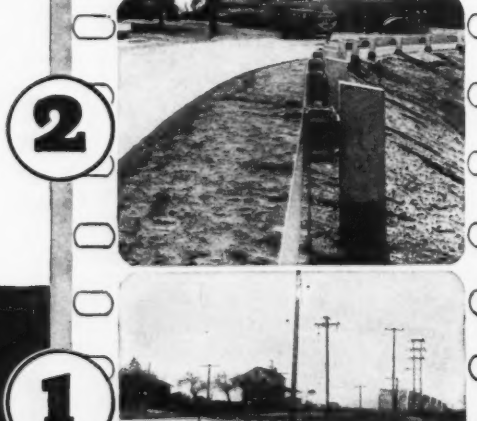

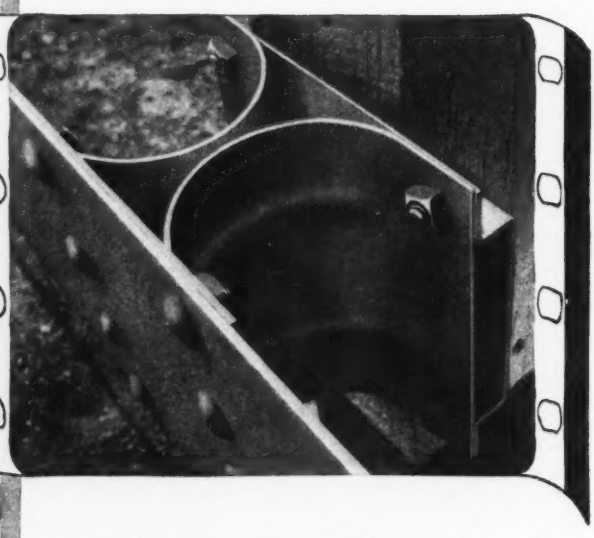

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THE WEEK'S EVENTS

Congress Passes River Bills

State control debated by Senate; Norris objects to increasing army control

Federal vs. state control of "incidental" power, and the attitude of the Corps of Engineers toward its development, played a prominent part in Senate debate on two bills during the closing days of the 75th Congress. Amendments adopted to both the river-and-harbor and flood-control authorization bills upheld the Administration's point of view on these questions.

In debating the river-and-harbor authorization bill on June 8 Senator Norris of Nebraska objected strongly to the statement of policy, which directed that "hereafter federal investigation, *planning* and prosecution of improvements of rivers, harbors and *other waterways* for navigation and *allied purposes*" shall be a function of the Corps of Engineers. (Italics indicate phraseology opposed by the Senator). He contended that this language would set up the War Department as a policy-determining body over not only navigation improvements, but also over flood control, power development, reclamation, and the runoff-retarding and soil erosion control measures carried on by other departments of the government; in fact, overall proposals having to do with the utilization or control of water resources.

Senator Barkley of Kentucky supported this view, pointing out that approval of the provision as worded would forestall the work of the National Resources Committee or of any other body that might be set up, as proposed in the pending regional authorities bill, to prepare comprehensive plans in the field of conservation.

Copeland defends bill

The proposed language was defended by Senator Copeland of New York, chairman of the committee that reported the bill, who argued that the objectors were reading far more meaning into the language than was intended, and that Congress could at any time take away from the Corps of Engineers any powers which it might wish to delegate to another agency. The matter was finally compromised by substituting without change the language used in previous acts so that the bill now reads: "Federal investigations and improvements of rivers, harbors and other waterways shall be prosecuted by the War Department . . . . except as otherwise specifically provided by act of Congress."

As passed shortly thereafter, the bill authorized the construction of 53 navigation projects with a total cost of $37,104,350, an increase of $3,200,500 over the bill as approved by the House April 27. This was accounted for by the addition of 14 projects approved by the Board of Engineers for Rivers and Harbors since the House action. The only other amendment of importance added by the Senate was a direction that hydrologic studies now being conducted along the line of the proposed Nicaragua Canal be continued.

On the following day the House, with very little debate, accepted all Senate amendments and sent the bill to the White House for signature.

Flood Control Bill

The same issue arose in the consideration of the flood-control authorization bill, which was taken up by the Senate on June 9, and the same solution was adopted: the revised language of the bill was abandoned in favor of a declaration of policy copied from the omnibus flood-control act of 1936. This gives the Corps of

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Walter S. Rae Wins Tunnel Suit

Awarded damages on Reading water supply contract rescinded because of misleading borings

A jury in the U. S. District Court at Philadelphia has awarded Walter S. Rae, contractor of Pittsburgh, Pa., damages amounting to $61,859 in a suit brought against the city of Reading, Pa., charging misleading borings on a tunnel contract. Rae received the contract for driving the Maiden Creek water supply tunnel for Reading, including an open-cut creek crossing, Mar. 31, 1934. On Aug. 28, 1934, after sinking a shaft about midpoint on the tunnel and driving 85 ft. of heading each way, the contractor rescinded his contract, claiming the log of the borings as shown on the plans and the core samples failed to disclose the true character of the ground (*ENR* Sept. 6, 1934, p. 314). The suit was brought to recover expenses incurred in the start of work and to force payment of an estimate claimed due by the contractor.

The contract plans showed a profile of borings supposedly taken in 1927. Before the contract was let, the line of tunnel was shifted 150 ft. at one end and a few feet at the other. The grade was also lowered, and final grade was 35 ft. below bottom of borings at one end. All boring logs on the plans showed solid limestone at the bottom of the holes. In preparing the final plans the city engineer transposed the assumed solid rock line as developed by the borings to the new tunnel line. Typical cross-sections shown on the plans indicated solid rock throughout; there was no provision for ground supports.

Instead of encountering solid rock as expected, the contractor found only mud and boulders in the 170 ft. of tunnel excavation completed. Thinking the condition might be local, he complained orally to the engineer from the first, but kept working several weeks in the hopes of striking solid ground. The contractor also discovered after starting work that the original core box numbers did not correspond to the hole

(*Continued on p. 828*)

Congress Passes River Bills

(*Continued from page 827*)

Engineers authority over the investigation and improvement of rivers for flood control, but places measures for water retardation and soil erosion prevention on watersheds under the Department of Agriculture. In addition, the Senate modified the usual provision that penstocks *may* be installed in flood control dams to facilitate the later development of power to make this feature mandatory in all dams when approved by the Federal Power Commission. The $5,000,000 allocated in the House bill to each of the two agencies (Corps of Engineers and Department of Agriculture) for examinations and surveys over a five-year period was supplemented by an additional $5,000,000 earmarked for the Federal Power Commission.

Cost allocation

The House modification of the principle of local cost contribution permitting the federal government to reimburse 70 per cent of this amount when used for dam and reservoir construction was expanded to include channel improvement projects when undertaken for flood control purposes. The relocation or reconstruction of roads, railways and other utilities was included in this amendment as a cost subject to the 70 per cent reimbursement, but subsequently an amendment was added transferring such items to construction cost, which is a 100 per cent federal expense. This disparity will be eliminated by the conference committee.

Another incongruity was then added by the adoption of a subsequent amendment, also sponsored by Senator Barkley, directing that in the case of dam and reservoir projects the federal government shall acquire directly and assume title to all necessary lands, easements and rights-of-way, reimbursing local authorities in full for any expenses hitherto incurred for such purposes.

All policy amendments were made retroactive applying to projects hitherto authorized as well as to the list carried in the present bill. The effect of the conflicting amendments is to give the Senate's conferees optional plans.

New projects added by the Senate to the list in the House bill included the authorization of local protective works on the Merrimack River to supplement reservoirs already approved; the Lugert-Altus flood control and reclamation reservoir on the North Fork of the Red River, Okla., and the Blakely Mountain reservoir on the Ouachita River, Ark. In addition the Senate changed the terms of the federal payment in lieu of taxes on lands to be acquired in the Morganza floodway, and added numerous other less important amendments.

Despite the fact that the Senate bill added about $20,000,000 construction costs and possibly as much as $80,000,000 in additional expenses assumed by the federal government the total authorization of $375,000 was left unchanged.

The Lugert-Altus project is primarily for reclamation, but also has some value for flood control and for domestic water supply. Its cost was estimated at $5,353,000 in a favorable report submitted to Congress last April by the Department of the Interior. The authorization in this bill directs that an agreement be reached between the Army and the Department of the Interior for the allocation of costs before construction can be started.

The Blakely Mountain projects has been licensed for private development by the Arkansas Power & Light Co. as a hydroelectric power development.

Development of excess storage capacity for flood control purposes has been recommended. The authorization in this bill permits the federal government to assume the additional cost of developing this excess capacity, and is sharply limited by a number of provisions to cover only the flood-control part of the development, and in on case to exceed $2,000,000.

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Walter S. Rae Wins Tunnel Suit

(*Continued from page 827*)

numbers given on the plans; the holes being numbered consecutively from one portal, the core boxes from the other end.

The contract provided payment per foot of completed tunnel, and the engineer refused to allow a partial estimate for excavation only. Upon refusal of the estimate and finding the bad ground continued indefinitely, the contractor rescinded his contract and instituted suit against the city.

The jury found that the plans and specifications upon which Rae bid made material misrepresentations as to the character of the subsoil, the falsity of which could not reasonably have been discovered by the contractor; that the contractor relied upon the misrepresentations and was damaged thereby; and that the contractor was entitled to an estimate for work done up to the end of July. The jury upheld the plaintiff's contention that it was common practice to break a unit price per foot of tunnel down into its component parts and allow the contractor payment for work done.

Bonneville Rates Approved by F. P. C.

"At site" and uniform transmission line rate schedules prepared for diversified use of energy

The Federal Power Commission on June 10 approved revised Bonneville Dam power rate schedules submitted by J. D. Ross, administrator. Schedules adopted are for "at site" power and for transmission system power. These schedules, the commission states "can reasonably be expected to yield sufficient revenues to recover . . . the allocated cost of producing and the cost of transmitting electric energy produced at the Bonneville Project, including amortization of the allocated capital investment over a reasonable period of years."

The rates per kilowatt year as approved are the same as were proposed by the administrator for prime and secondary power (*ENR* May 19, 1938, p. 701) and are as follows:

At Site Rates—Prime power, $14.50 per kilowatt year; secondary power $9.50 per kilowatt year. Available to private purchasers for their own use, but not for resale; and to public bodies, cooperatives, and privately owned electric utilities for distribution within 15 miles of the Bonneville Power Plant.

Transmission System Rates—(Uniform over entire transmission system.) Prime power, $17.50 per kilowatt year; secondary power, $11.50 per kilowatt year. Available to public bodies, cooperatives, and privately owned electric utilities for resale only.

Changes were made in terms and conditions, availability and in certain other particulars and the number of rate schedules originally submitted by the Administrator was reduced from nine to four. The proposed schedules for the sale of surplus power were eliminated and will be submitted at the time the need arises.

• • •

Missouri Country Club Must Pay WPA

Orders have been issued to the Poplar Bluff (Mo.) Country Club to pay $926 to the government for WPA work done on its property. Work was done as a part of a county-wide road improvement project. The country club is on a branch road and the WPA workers improved its approaches and drives while working in the public project. Investigators later found the work could not be included in the road project, and recommended that the country club reimburse the United States Treasury.

THE CURRENT TREND

This week's news of contract volume and construction cost factors

Urban Housing Up 9.7 Per Cent

Middle Atlantic, West North Central and West South Central report gains over first quarter of 1937

New dwelling units provided in urban areas in United States during the first quarter of 1938 total 60,127, an increase of 9.7 per cent over the 54,814 units reported for the corresponding 1937 quarter. These reports from the Bureau of Labor Statistics are based on building permit totals from 1700 cities. They represent 88 per cent of the urban population.

Multi-family dwellings, 55.9 per cent above the 1937 volume, are responsible for the gain. One-family units dropped 12.6 per cent below last year; two-family units equalled the 1937 mark.

By population groups, the large centers and smaller cities show gains over the 1937 quarter. Medium-sized population groups, that is, from 10,000 to 500,000, run 5 to 20 per cent below last year. Housing in cities over 500,000 population is 38 per cent above last year; in towns of 5,000 to 10,000, 3 per cent higher; and in towns of 2,500 to 5,000 population, 1 per cent higher.

Geographically, Middle Atlantic states have provided 54 per cent more dwelling units this year than in the 1937 first quarter; West North Central, 17 per cent more; and West South Central, 7 per cent more. All other sections report losses ranging from 12 per cent in both East South Central and Mountain States, to 34 per cent in New England.

Middle Atlantic provides 28,670 dwelling units, 48 per cent of the total for the country. Of this region's total, 22,312 are multi-family dwellings, 83 per cent of the total multi-family units provided in the country, in the 1938 first quarter.

Building Permits

April permit valuation of building construction in 2025 U. S. cities totals $136,241,519, an increase of 12.8 per cent over March, but 24 per cent below April, 1937, as reported by the Bureau of Labor Statistics. The April, 1938 total is made up of $60,854,744 in new residential building, 10.6 per cent above March; $44,675,273 in non-residential, 14.3 per cent higher; and $30,711,502 in alterations and repairs, 15.3 per cent higher.

During April, 16,198 new family dwelling units were provided, 11.3 per cent more than in March. All sections, except East and West South Central, exceed their March dwelling unit totals.

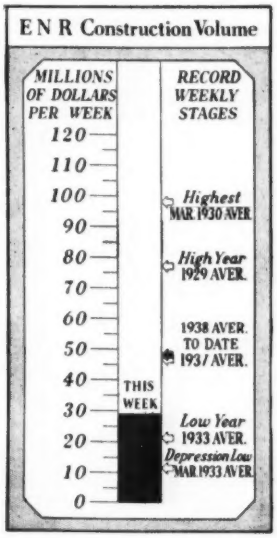
Total permit values for the 4 months of 1938, $526,663,000, are 8.7 per cent below the corresponding 1937 period. New residential is 13 per cent lower, alterations and repairs 12.8 per cent lower, while non-residential construction is 1.0 per cent higher than in 1937.

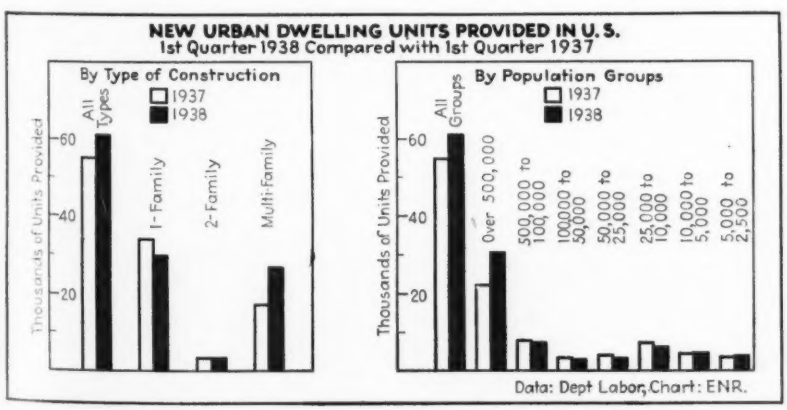
Portland Cement

Portland cement production for April, 1938, totals 7,983,000 barrels; shipments, 8,678,000 barrels; and stocks at the end of the month, 22,283,000 barrels, according to the U. S. Bureau of Mines. Production is 36 per cent above March, but 23.3 per cent below April, 1937. Shipments are 20 per cent above March, but 15.5 per cent below a year ago.

Production for 4 months of 1938, 22,312,000 barrels, and shipments, 24,902,000 barrels, are 29 and 11 per cent lower, respectively, than the corresponding 1937 period.

Ratio of production to capacity of mills is 37.7 per cent for April, 1938, compared with 26.9 per cent for March, and 48.8 per cent for April, 1937.





THIS WEEK'S FIGURES

(Thousands of Dollars)

CONTRACTS

	Week Ending June 17 1937	June 9 1938	June 16 1938
Federal	$4,049	$5,435	$ 338
State & Municipal	28,533	32,303	21,434
Total public	$32,582	$37,738	$21,772
Total private	47,798	9,699	7,415
TOTALS	$80,380	$47,437	$29,187

Cumulative
1938 (24 weeks).....$1,153,739
1937 (24 weeks).....$1,129,898

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000 other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1937 24 Wk.	1938 24 Wk.
NON-FEDERAL	$588,851	$675,112
State & Mun. bonds	250,451	318,458
Corporate securities	267,612	179,728
PWA loans, grants	40,849	2,036
RFC loans	29,939	63,820
U.S.H.A. loans	.....	111,070
FEDERAL	.....	$86,532
TOTAL CAPITAL	$588,851	$761,644

FHA MORTGAGES

	Cumulative 1937 23 Wk.	1938 23 Wk.
Mortg. selected for appraisal	$301,067	$397,489

ENR INDEX NUMBERS

Index Base	1913	1926
Construction Cost (June)	236.86	113.86
Building Cost (June)	198.22	107.15
Construction Volume (May)	167.00	73.00

OBITUARY

JAMES ERNEST DAVIES, 81, civil engineer who helped in the industrial development of the Republic of Colombia fifty years ago, died at Belleville, Ill. June 2.

GUSTAVE A. TORELL, of Carlson & Torell Co., New Britain, Conn., general contractors, died June 3 at the age of 48.

WILLIAM G. LANGENHEIM, 67, who had supervised many projects, including the bridge connecting Key West with the mainland of Florida, died in Carlsbad, Calif., May 19. He was an associate of the late Joseph B. Strauss, builder of the Golden Gate Bridge at San Francisco.

CARL C. THOMAS, engineering educator and inventor, died in Pasadena, at the age of 65. Associated with several educational institutions and industrial concerns during his life, he was most recently an associate in engineering research at California Institute of Technology.

WALTER B. BINFORD, JR., 40, civil engineer in the Bureau of Valuation of the Interstate Commerce Commission, died in Washington June 1.

JAMES HERVEY DINGLE, city engineer at Charleston, S. C. since 1894, died there June 3 at the age of 69. He was a past president of the South Carolina Society of Engineers and of the South Carolina Section of the American Society of Civil Engineers. In 1931, the American Society of Municipal Engineers awarded him its medal for longest continuous service under one employer. He had served under seven mayors.

PERCY W. BELL, city engineer at McCook, Nebr., for the past several years, died recently.

HENRY L. LYON, 86 years of age, former commissioner of water at Buffalo, died May 28. He started his career as a surveyor, laying out Buffalo's Delaware Park. Later he was a mining engineer in northern Ontario and in Utah.

MARVIN A. HOWLAND, 61, chief civil engineer for the J. Neils Lumber Co. at Goldendale, Wash., died there May 27.

FRED MCCULLOCH, former engineering inspector for PWA in West Virginia, died recently in Chicago at the age of 58. He was formerly superintendent of the Point Pleasant, W. Va. Water & Light Co.

Wide World Photo

CROSSING THE RIVER JORDAN

ALLENBY BRIDGE No. 3, recently completed over the Jordan between Palestine and Transjordan is shown above. Its predecessor which is a considerably lighter structure, is shown in the background. Bridge No. 3 was opened May 18 for traffic. It was officially tested by two lines of heavily loaded trucks, one of which can be seen above.

Allenby Bridge No. 1 was hurriedly thrown across the river for British troops during the World War. This was later replaced by Bridge No. 2, which has served for many years and more than once has been swamped by the extreme overflow of the Jordan. The bridge that is being replaced has not finished its service, since it is to be moved farther up the river to Jisr Damieh near Beisan.

LEIF LEE, consulting engineer and former chief engineer of the Youngstown Sheet & Tube Co., died May 27 in Youngstown.

JAMES A. HALL, 43, of Youngstown, Ohio, a construction engineer for the Rust Engineering Co., died May 27 at Braddock, Pa.

FRED CRICHTON, 65, safety engineer for the Oregon WPA, died June 6 at North Bend, Ore.

C. H. GEIST, director of many utilities and land enterprises during his life, died in Philadelphia June 12 at the age of 72.

• • •

Paducah Sells Bonds For Levee Lands

Paducah, Ky. has sold $200,000 in bonds voted last year for the purchase of levee right-of-way land, to the Cincinnati firm of Nelson, Browning & Co. The interest rate payable on the 50-year issue, was the lowest in the history of the city—3¼ per cent. The city is required to obtain enough land to insure start of the wall by July 1, or the Federal appropriation may be withdrawn.

Los Angeles Flood Report Recommends Channels

Recommendations for adequate channels to facilitate runoff, and recommendation against further construction of mountain reservoirs, are made in a preliminary report on the operation of the Los Angeles County Flood Control District's structures during the severe flood of March 1938. C. H. Howell, author of the report, and chief engineer of the district, maintains that the accumulation of silt in basins, with consequent loss of water storage space, renders them economically unfeasible. Percentage loss in storage capacity due to this single storm on several of the district's large reservoirs range from 9 per cent to 82 per cent. Three of the dams, however, were built primarily for debris retention.

The report finds that pipe and wire, piling and wire, and pneumatically placed concrete channel protection are unsatisfactory for swift water or on curves. The open concrete channels were undamaged and Howell speaks highly of the rock and wire mattress protection. More than 100,000 ft. of this type was subject to high velocities and heavy debris flow, but remained intact and largely undamaged.

Contractor Fined for Violating Silicosis Act

The Garafano Const. Co., Inc., of New York City, was the first contractor to be convicted of violation of the state silicosis act which requires the use of dust control equipment in connection with rock drilling. The company plead guilty to charges preferred by the state before Magistrate Aurelio in the Bronx Magistrate's Court on June 8 and was fined $25. On Mar. 30, the complaint charged, a state department of labor inspector found the contractor, engaged in rock drilling operations on the East 138th St. approach to the Triborough Bridge, operating two wagon drills without the use of dust control equipment. On that date the contractor was ordered to install the equipment as required by law, but a subsequent visit by the inspector on Apr. 14 revealed the equipment was still not being used, though dust control apparatus had been placed on the job, but was not connected to the drills. On four subsequent inspections the state inspectors found the apparatus on the job but not being used, though drilling was in progress.

Dust counts made by the state disclosed an average concentration of 24 million particles per cu. ft. of air on the Garafano job. The law holds concentrations in excess of 10 million particles as harmful.

• • •

Assessment of Road Pay Charged in Missouri

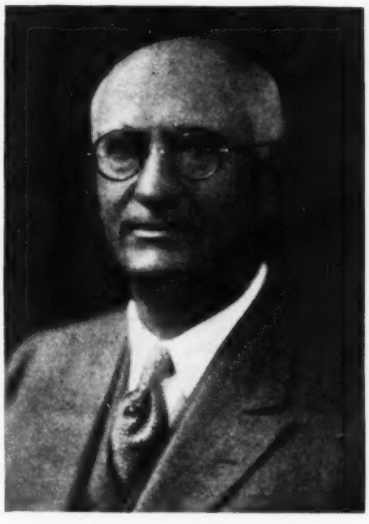
Charging the assessment of the pay of state highway department employees for the purpose of raising a campaign fund for a constitutional amendment sponsored by the Citizens Road Association is "an arbitrary abuse of authority subject to severest criticism and condemnation," Roy F. Britton, president of the Automobile Club of Missouri, has resigned as a member of the Board of Directors of the association. Britton also objected to circulation by department employees of initiative petitions for the proposed amendment, which would levy a tax of 3 cents a gallon on gasoline used as fuel in motor vehicles, and asserted the appearance of his name as a director on the petition gives the impression he is in favor of the proposition and is therefore misleading to the public.

Britton's resignation followed the disclosure last week of the assessment, ranging from 1 to 3½ per cent of the monthly pay of highway employees from now until election. The collection was described as voluntary and is expected to raise between $15,000 and $18,000.

E. N. Hines, Road Builder, Dies in Detroit

Edward N. Hines, member of the Wayne County Road Commission, Detroit, for 33 years since its inception in 1905 and widely known as a good roads disciple and pioneer in concrete road construction, died suddenly at his home June 4 following a heart attack.

Wayne County's outstanding highway system (*ENR*, Nov. 25, 1937, p. 857; Dec. 16, 1937, p. 981) is attributed largely to the vision and



EDWARD N. HINES

efforts of Hines, and the accomplishments of the county have influenced road building throughout the United States. Even before the advent of the automobile as an important factor of transportation, Hines became interested in good roads for bicyclists and was president of the Detroit Wheelmen, later becoming vice-president of the League of American Wheelmen. During his 33 years as commissioner, the improved county roads in Wayne County have increased from practically none to over 2000 miles now under the commission's jurisdiction. Over 700 miles of the county's roads are paved.

One of the first miles of concrete road in the country was built on Woodward Ave. in Detroit under Hines' direction; the width of 20 ft. was an early practice of the commission. In his later years his greatest enthusiasm was for parkways and landscaping along the scenic highways of Wayne County. A part of the Middle Rouge Parkway along the Rouge River near Northville recently was named Edward N. Hines Parkway Drive in his honor. He was credited as the originator of the center traffic line for marking highways.

Power Commission Wins Decision

Court decides commission's findings cannot be reviewed in Yadkin River development

Contention of the Federal Power Commission that its findings regarding the navigability of a river are not reviewable was sustained by the United States Circuit Court of Appeals for the Fourth Circuit in a decision handed down June 6 against the Carolina Aluminum Co., which had sought a review of the commission's finding regarding its proposed $6,000,000 hydroelectric power development on the Yadkin River near Tuckertown, N. C.

In the belief that the river is not navigable, the company, as required by law, on June 7, 1937, filed a declaration of intention to construct the plant. The commission, in order to collect evidence on the point, held a public hearing July 23 and directed filing of brief by Sept. 15 (*ENR*, Sept. 16, 1937, p. 449). At this hearing, the commission found that the Tuckertown project would affect the interests of interstate commerce on the Pee Dee River in South Carolina.

The commission's decision was based on the finding that, although four unlicensed dams are operating between the project and the head of navigation, operation of the proposed dam might cause serious fluctuation in the flow of the river in its navigable section (*ENR*, Nov. 25, 1937, p. 841).

The court's decision appears to have no bearing on the question of whether the project will affect navigation on the lower river and so is subject to control by the commission. The court concerned itself with the question of whether a finding by the commission to the effect that the project does affect navigation constitutes a "reviewable order". It found that it was not such an order, thus leaving the basic question still open.

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Canadian Parliament Proposes City Loans

In a further attempt to stimulate employment in Canada, the federal government has introduced a bill in the House of Commons at Ottawa, giving the government power to make loans to municipalities at an interest rate of 2 per cent. Such money would be loaned only for self-liquidating projects and only after these had been approved by the respective provincial governments, which would also guarantee the loans as to principal and interest.

PERSONAL

RUFUS E. ZIMMERMAN, vice-president of research and technology, United States Steel Corp., was awarded a degree of Doctor of Science from Franklin and Marshall College, Lancaster, Pa., June 1.

LT.-COL. DAVID MCCOACH, JR., will become engineer commissioner of the District of Columbia Sept. 9.

EDWARD S. LANPHIER, superintendent of the 8th U. S. Lighthouse Service District, New Orleans, has retired from service. He has been in the service for 46 years and is past-president of the Louisiana Engineering Society and of the Louisiana Section of the American Society of Civil Engineers.

EDWARD C. MERRILL has been made superintendent of the 8th U. S. Lighthouse Service District, New Orleans, succeeding Edward S. Lanphier.

THOMAS E. SPEERS has been appointed consultant engineer on the staff of Benjamin P. Groves, district supervisor of the National Youth Administration, Cincinnati.

DAVID MCKEITH, in Milwaukee's city service since 1895, and supervisor of buildings since 1932, has retired.

BERT J. PINSONNEULT has been appointed highway engineer for Red Lake county, Minn., at Red Lake Falls.

ERIC KEBBON, architect, has been nominated for the position of superintendent of school building design and construction in New York City.

SAMUEL SHULITS, of the Department of Mechanics at Colorado School of Mines, has been appointed a lecturer in hydraulics at the University of Iowa for the summer session.

FRED B. MCKINNELL has been appointed city executive engineer at Kansas City, Kan. In this newly created position he will supervise the city's properties on the municipal levee and represent the city in construction of a terminal food market and in a $1,750,000 terminal elevator.

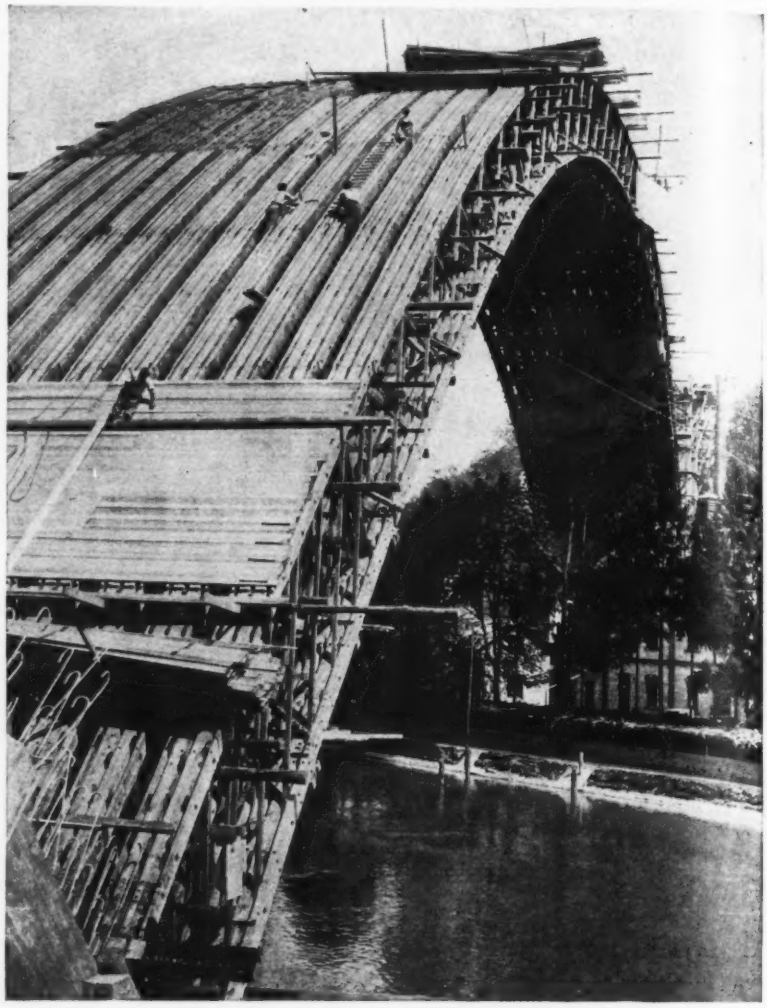
W. FRANK HARRIS, Toledo contractor, has been made service director there.

Hal W. Hunt is now field engineer on the anchorage and approach contracts for the Bronx-Whitestone Bridge in New York.

HAROLD EPSTEIN, PWA project engineer in the construction of Buffalo's $15,000,000 sewer and sewage project since late in 1935, has been named general manager of operations for the Buffalo Sewer Authority. Epstein has been directed by the Authority to proceed at once with the organization of operating personnel for the new treatment plant and to perfect an organization by July 1.

CHARLES E. SISSON, a Canadian General Electric Co. engineer, was recently made the chairman of the Toronto section of the Engineering Institute of Canada.

E. N. HORSEY, engineer, was recently made manager of the light and power department of the British Columbia Electric Railway Co., Ltd., succeeding the late F. J. Falls.



A NEW GATEWAY TO THE BERNESE OBERLAND

THIS mighty arch of scaffolding, containing more than 500,000 board-feet of timber, spans the River Aare at Berne, Switzerland. Built at a cost of $625,000, the bridge will contain 32,500 cu.yd. of concrete. When completed it will carry four tracks 150 ft. above the river.

Power Plant Ouster Suit Filed in Missouri

A suit to oust the Missouri Public Service Corp., electric power firm, from Trenton, Mo., has been filed in the Missouri Supreme Court on behalf of the city of Trenton, which now operates a municipal power plant and distributing system, constructed recently with proceeds from a $250,000 bond issue.

The suit charges the utility company does not have a franchise to operate in Trenton, and is engaging in illegal competition with the city's plant. According to the petition the ouster action was brought because the company refused to comply with a recent city ordinance directing it to cease operations in Trenton and remove its plant and equipment from the city.

F.P.C. Modifies License For Possum Kingdom Dam

The Federal Power Commission on May 25 modified the license for Possum Kingdom Dam in Texas, which it tendered to the Brazos River Conservation and Reclamation District on May 13 (*ENR*, May 26, p. 729). This action was taken following receipt of a petition from the district that the commission hold a new hearing on its application for a license, the district having reached the conclusion that the project will have no effect on the navigability of rivers over which the U. S. Government has jurisdiction. (The dam is 690 miles from the mouth of the river and ships plying in interstate commerce come up only to Freeport, about 6 miles from the Gulf.)

As a result of the commission's modification of its order of May 13, the district withdrew its request for a new hearing.

Concrete specifications

The original order was significant in that the Federal Power Commission took upon itself the right to specify minimum compressive strengths for Class A concrete and for reinforcing steel. The modified order retains the design specifications, amplifying their application somewhat.

The order's major changes are in the section relating to the reasonable rate of return from the investment and the amortization of the cost of the project, also in the requirements for the start of work and completion of the project which have been amplified to require that two 10,000 kw. generating units be installed on or before July 1, 1941, and that a third unit shall be installed "at such time as the commission may direct."

The section declaring that the license is not intended to affect the laws of the state of Texas relating to the control, appropriation, use or distribution of water used in irrigation or for municipal or other uses has been amplified to cover the act creating the district, but the amplification is apparently nullified by the last clause which reads "which are not inconsistent herewith."

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"Clover Leaf" to Be Built In British Columbia

British Columbia's first "clover leaf" highway junction will be established at the north end of the First Narrows bridge, Vancouver, according to plans of government engineers. Latest engineering design of such intersections, as developed in New York State, will be embodied in the structure.

CALENDAR OF MEETINGS

NATIONAL SOCIETIES

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Chalfonte-Haddon Hall, Atlantic City, June 27-July 1.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, annual meeting, Texas A. & M. College, College Station, Texas, June 27-30.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, summer convention, Washington, D. C., June 20-24.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Hotel Utah, Salt Lake City, July 20-22.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, Pacific Coast convention, Portland, Aug. 9-12.

AMERICAN SOCIETY OF PLANNING OFFICIALS, Minneapolis, June 20-22.

PUBLIC HEALTH BACTERIOLOGY, summer course, Massachusetts Institute of Technology, Cambridge, June 13-July 22.

A.S.M.E., semi-annual meeting, hydraulic section, Hotel Statler, St. Louis, June 21.

AMERICAN WATER WORKS ASSOCIATION, Central States Section, Hotel Windsor, Wheeling, W. Va., Aug. 17-19.

ELECTIONS AND ACTIVITIES

THE MONTANA SECTION of the American Water Works Association is sponsoring bills to remove municipal water department operators in Montana from politics. It is proposed to license regular water department employees and place them on a civil service basis.

J. W. COTLIN has been elected president of the Engineers Club of Birmingham succeeding E. A. Hamilton. Other offices include Ray Crow, vice-president; Robert Klein, secretary-treasurer; R. E. Kirk, Hugh A. Powell, and Jack Yauger, directors. Sixty-six new members have been taken into the organization in the last year, bringing the membership to 389.

H. A. DURDEN has been elected president of the newly formed engineers club of the Sixth Division, Georgia State Highway Department. Clubs similar to this one are being formed in all of the six highway divisions of Georgia.

THE following officers were elected by the Engineers Club of Baltimore June 2: Robert M. Reindollar, president; Ralph L. Thomas, first vice-president; H. B. Prewitt, second vice-president; L. P. Kimball, treasurer.

Crossing Cost Revision Proposed in New York

Railroads operating in New York State would be relieved of the expense of grade crossing elimination work in future under the provisions of a proposed constitutional amendment now before the constitutional convention in session at Albany. Under the terms of the proposed measure, grade crossing elimination work not actually commenced before Jan. 1, 1939, would be paid for in whole by the state, thus relieving the carriers of any expense involved in connection with the balance of the $300,000,000 grade crossing elimination program authorized by popular vote in 1926. Under the terms of that program when originally adopted by constitutional amendment, the railroads have been required to bear 50 per cent of the cost of grade crossing elimination work. The state has been paying for 49 per cent of the cost with 1 per cent being borne by the county in which the work is located. The measure now under consideration would also relieve the counties of their 1 per cent share now being carried.

This measure, if finally ratified by popular vote, would apply on a total volume of nearly $200,000,000 in grade crossing work, representing the approximate volume remaining to be performed under the original authorization. Grade crossing work under the original $300,000,000 has progressed slowly because of inability of the carriers to meet their 50 per cent share of the cost of the work as it is ordered from time to time by the Public Service Commission.

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Bids on Shasta Warehouse Opened at Sacramento

Arrangements for construction of Shasta Dam went ahead another step June 3, when bids were opened for the building of a government warehouse and storage yard in the Sacramento River Canyon at Coram, about a mile downstream from the dam site. This will be served by railroad spur tracks, and will be the government's point of delivery to the general construction contractor.

The Heafey-Moore Co. and Fredrickson & Watson Construction Co. of Oakland, submitted the low bid of $83,182. Nine bids were received for the job which include the erection of a steel-frame warehouse 380 ft. long and 70 ft. wide, grading for a storage yard in the mouth of a side canyon at Coram, and construction of a drainage channel for a creek which flows into the river from this canyon.

Belleville Entitled To Only One Premium

The city of Belleville, Ill. is not entitled to an additional premium from H. C. Speer & Sons Co., Chicago investment bankers, from the sale of $582,000 city bonds, according to a legal opinion filed with the Belleville city clerk by the city attorney.

Belleville sold the bonds to the Speer Co. May 6, receiving a premium of $6,011. The company resold the bonds for a $65,000 premium. The city council upon learning of the bond sale for a premium ten times what it received, instructed the city attorney to bring suit to recover half of the larger premium. The attorney's opinion stated that the city contract with the bond house barred such a lawsuit, and that the $6,011 it received under the contract is all it is entitled to.

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Seattle Housing Project Contracts Awarded

Contracts have been awarded at Seattle for a $1,360,000 housing project. The project was planned and promoted by the architectural and engineering firm of Graham & Painter, Inc. of Seattle, New York and Shanghai, for the Madison Park Housing Corp. The general contract was awarded to the Henrickson-Alstrom Construction Co., of Seattle. The project includes 18 two-story brick veneer and frame apartment structures, heated with 14 oil-burning plants and containing 304 three and four-room suites. Eight months will be required for completion.

To enable construction of the project at a cost that could assure a return on the investment, the city council amended the building code to permit use of gypsum wallboard in lieu of wood lath and plaster, in the zone in which the project is located.

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Seattle Builders Union To Keep Six-Hour Day

Building trades unionists of Seattle, have voted 3,270 to 564 to retain the six-hour day in the Seattle building industry. The referendum has been requested by the Seattle chapter of the Associated General Contractors and the Master Builders' Association.

Seattle building activity was hampered for several weeks in March, when contractors refused to hire men for less than eight hours a day and the unionists refused to work for more than six. Work was resumed on a six-hour basis pending arbitration.

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

THE SENATE on June 7 passed a bill amending the Walsh-Healey government contracts act by applying its provisions to all contractors with the federal government for materials, articles, equipment or services (except professional services) to the amount of $2,000 or more and to sub-contractors for $500 or more. The limitation in the present act is $10,000.

THE SENATE on June 7 passed, with minor amendments, a bill providing for the regulation by the Federal Power Commission of natural gas moving in interstate commerce. The bill was approved by the House July 1, 1937, and was favorably reported by a Senate committee on August 11. It gives the FPC broad regulatory powers over natural gas similar to those already exercised in the field of electric power transmission.

THE SENATE on June 9 passed and sent to the White House for approval a House resolution creating a Niagara Falls Bridge Authority and authorizing it to build and operate a bridge across the Niagara River near Niagara Falls.

WITH the Supreme Court in recess, Associate Justice Owen J. Roberts has signed an order postponing the effective date of the court's recent decision holding that employees of the Port of New York Authority are liable for federal income taxes until action can be taken next fall on a petition for rehearing.

The effect of the order is to withhold the formal mandate of the court, and thus make it impossible for the government to attempt the collection of the tax.

THE Bureau of Reclamation will open bids July 11 at Sacramento, Calif., for the construction of a steel bridge to carry the relocated Southern Pacific Railroad across the Sacramento River near Redding, Calif., in connection with the construction of its Central Valley project. The structure will have a total length of 4,347 ft., comprising three 169-ft. river spans on reinforced concrete piers and 71 approach spans with lengths varying from 35 to 80 ft. supported by steel bents. Separate bids are requested: one schedule provides for the abutments, pedestals and piers; the other for the superstructure and track. Some materials will be purchased by the government under separate contracts.

Four Workmen Killed In Montreal Fall

Four workmen on the St. Joseph Oratory in Montreal were killed June 3 when a construction hoist car in which they were riding fell about 150 ft. Construction was begun on the present building in 1928, ceased in 1932, and resumed last fall. When completed, it will be the highest building in Montreal, its cross being 503 ft. above the adjacent road.

The exact cause of the accident, which shattered the hoist car and crushed the men on the floor of the church, is not yet known although accounts of the accident suggested that the bail on the hoist car snapped, allowing the car to drop.

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Pollution Control Body Is to be Organized

After a deadlock lasting nearly a year, the conference committee on the stream pollution bill on June 7 reached agreement on a measure setting up in the Public Health Service a division of water pollution control but denying this body authority to enforce its orders. The provision for federal loans and grants to aid in the construction of purification works, however, was retained. The bill was passed by the House June 13.

Proponents of a bill with teeth in it are understood to have yielded on this controversial point on the understanding that the effectiveness of advisory findings will be tried out. If experience proves that pollution conditions cannot be remedied by the comparatively weak measure approved, additional legislation will be introduced.

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Missourians to Petition for Higher Gas Tax

The Missouri Citizens' Road Association will soon start circulating initiative petitions to place its state highway program on the November ballot. The program, adopted at a statewide meeting in May, provides for an increase in the state gasoline tax from 2 cents to 3 cents a gallon, and outlines the purpose for which highway revenue shall be spent. Chief among its provisions is one requiring the building of 5000 miles of new farm-to-market roads within ten years.

The petitions must be filed with Secretary of State by July 2, and must bear the signatures of at least 5 per cent of the legal voters and at least two-thirds of the state's congressional districts.

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Rock Cork Is Not Cork

Sir: In the article in the Dec. 9, 1937, issue on the new research building of the American Rolling Mill Co. at Middletown, Ohio, it is stated that the roof construction consists of a ½-in. layer of "acoustical cork" in the metal pan units and that the tops of these pans are covered with a galvanized corrugated steel sheet on top of which is a 1-in. layer of cork insulation. It is pertinent to point out that the "acoustical cork" is not cork at all but a mineral substance marketed under the name of "rock cork." The cork board insulation used above this, however, is cork and of our manufacture.

PAUL C. BUNKER
Armstrong Cork Products Co.
Lancaster, Pa.

Grid Water Systems

Sir: In your annual waterworks number, April 21, 1938, on page 570, in the article by Messrs. McDonnell and Timanus, the authors, in comment on the Hardy Cross method of computing grid-iron water systems, refer to "a simplification in the issue of March 3, 1937, p. 342." I can find no such reference as this. Will you please give me the proper reference for the second article?

I have used the Hardy Cross method of figuring distribution systems, and there is nothing like it. *Engineering News-Record* made a great scoop when you secured that article.

RICHARD BENNETT
Phoenix, Ariz., June 6, 1938

The article in question was published in our issue of March 3, 1938, not 1937 as stated. —EDITORS

Welded Stack Design

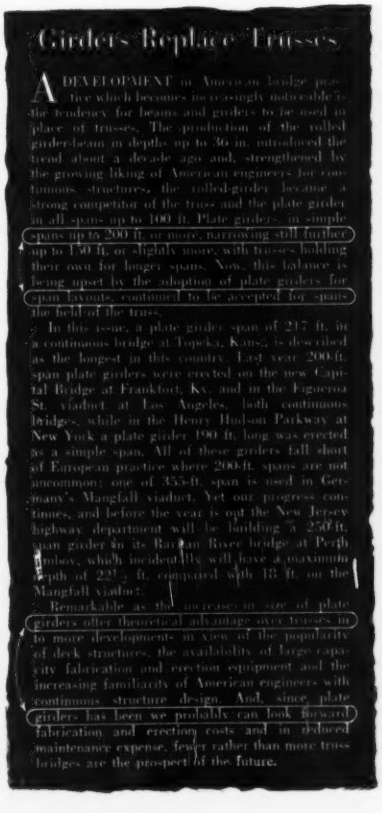
Sir: In your issue of May 19, 1938, p. 719, there appears an article entitled New Type of Weld for Steel Stack. Although all the statements given in this article are correct, we feel that some credit should have been given this office inasmuch as the stack was designed by us in our capacity as architects for Unit No. 15 of the Fisk Street Station.

MARVIN G. PROBST
Graham, Anderson, Probst & White
Chicago, Ill., May 27, 1938

Have you Figured It Out?

In the May 19 issue the printer, in a notable sleight-of-hand performance, interchanged several lines in the editorial "Girders Replace Trusses" The result was appalling, and the editors felt pretty blue, a feeling which was only infinitesimally improved by taking the printer to task. Readers, however, have raised our spirits considerably. In the first place, judging from the number of letters received, the editorial pages are read. Furthermore, the letters contain ample proof that readers have a sense of humor, several suggesting that they enjoyed unscrambling the hidden meaning and asking for more such puzzles.

But for those readers who were disturbed by the error, as we were, here is the answer to the puzzle. If the lines marked are interchanged, syntax is satisfied. —EDITOR



Girders Replace Trusses

A DEVELOPMENT in American bridge practice which becomes increasingly noticeable is the tendency for beams and girders to be used in place of trusses. The production of the rolled girder-beam in depths up to 30 in. introduced the trend about a decade ago and, strengthened by the growing liking of American engineers for continuous structures, the rolled-girder became a strong competitor of the truss and the plate girder in all spans up to 100 ft. Plate girders in simple spans up to 200 ft. or more, narrowing still further up to 150 ft. or slightly more, with trusses holding their own for longer spans. Now, this balance is being upset by the adoption of plate girders for span layouts, continued to be accepted for spans the field of the truss.

In this issue, a plate girder span of 217 ft. in a continuous bridge at Topeka, Kans., is described as the longest in this country. Last year 200-ft. span plate girders were erected on the new Capital Bridge at Frankfort, Ky., and in the Figueroa St. viaduct at Los Angeles, both continuous bridges, while in the Henry Hudson Parkway at New York a plate girder 190 ft. long was erected as a simple span. All of these girders fall short of European practice where 200-ft. spans are not uncommon; one of 355-ft. span is used in Germany's Mangfall viaduct. Yet our progress continues, and before the year is out the New Jersey highway department will be building a 250-ft. span girder in its Raritan River bridge at Perth Amboy, which incidentally will have a maximum depth of 22½ ft. compared with 18 ft. on the Mangfall viaduct.

Remarkable as the increases in size of plate girders offer theoretical advantage over trusses in to more developments in view of the popularity of deck structures, the availability of large capacity fabrication and erection equipment and the increasing familiarity of American engineers with continuous structure design. And, since plate girders has been we probably can look forward fabrication and erection costs and in reduced maintenance expense, fewer rather than more truss bridges are the prospect of the future.

Elevated Highway Design

Sir: Regarding the recent elevated highway competition, I would like to add to Mr. Holmen's letter published in your April 21 issue, p. 562 and to Mr. Eipel's letter in your May 12 issue, p. 672.

According to the announcement for this competition the structure may go through congested city districts and built-up streets and may be used and should be adaptable in any city. Also, it was stated that the competition would be judged by the originality of design, practicability of construction, adaptability to actual conditions, etc.

There is no doubt that some of the designs submitted contain excellent ideas, but I should think that the designs that have been awarded the two first prizes should conform somewhat more closely to the announced requirements.

The first prize design has—

A portal column arrangement measuring 14 ft. across, which causes entirely too much loss of the existing roadway. This is impractical.

The ramp (ingress and egress) lands on the sidewalk between the curb and the building line which is also impractical.

The highway is covered with grating. This allows dust, oil, grease, and tools to drop on the public and street below which I consider very objectionable.

Finally, the structure is about 85 ft. wide—too wide to go through a congested city district.

The second prize design is admittedly a copy of an existing part of a highway built in New York City, but could not go through a congested district because it is 129 ft. wide. This design is certainly not original.

There are very few cities in the United States that have (in congested districts) streets wide enough to accommodate either one of these two designs. For this reason the adaptability to actual conditions is very questionable unless some of the city blocks are partly torn down near the ramps.

GUSTAV MUELLER
Brooklyn, N. Y., June 10, 1938

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Editorial Offices at 330 West 42nd Street, New York

JUNE 16, 1938

FEW MEN in public-works development have served their community longer than did Edward N. Hines who died last week at his home in Detroit. For 33 years he was a member of the Wayne County Road Commission, sometimes as chairman and sometimes as a member only, but always as a forceful unit of that famous body of roadbuilders. A single county, even the county that contains the greatest automobile-manufacturing metropolis of the world, is a small field in the highway activities of a nation, but Wayne County made its name known throughout a nation and beyond its boundaries to other nations as a pioneer in modern road engineering. In a large way this reputation was due to the creative thinking and labor of Ed Hines as county road commissioner. A pioneer in the field of hard-surfaced roads, he has a long roster of inventions to his credit, but they count little against his greater ability to cast his imagination far ahead to the superhighway, beautification of roadside and structure, and a master plan of county main and secondary highways, and then drive on toward the practical realization of these objectives. A courageous and farseeing innovator passed with his death.

Threatening Shadow

INDISCREET REMARKS made in the heat of political warfare cannot always be taken seriously, and the recent Senatorial suggestion that a reclamation project was used as a pawn in the battle of votes on government reorganization should not be held to indict reclamation. But it does carry a warning of what may happen if reclamation is hitched to the chariot of politics. When reclamation gets into the Quoddy class it will meet the same fate as Quoddy—Congress with the united backing of the nation will turn thumbs down. Unfortunately, present reclamation policies lack clear definition of the economic worth of a project and, since many projects cost much more than they can earn, decision on the justification of a particular improvement is largely arbitrary. Such a situation holds out a standing invitation to political manipulation. It would be well if simple criteria were established for appraisal of a proposed reclamation project. The widely held Western view that any irrigation improvement is worth while so long as someone can be induced to furnish the money for its construction is not likely to be generally approved, and until a more acceptable principle is established the threatening shadow of politics will overhang reclamation.

Aid to Recovery

SINCE THE INCEPTION of the Public Works Administration campaign to stimulate recovery through activation of public works, in 1933, this powerful resource has found increasing use all over the world. The methods of different countries are diverse, but notable successes have been obtained—substantial employment of otherwise idle workers, and an impetus to business of a degree depending on the soundness of the campaign and the confidence it inspired. Canada's recent move in providing some forty million dollars for public works will give a further trial of this recovery aid. The Canadian method is related to our PWA but radically different from the WPA system; it aims to create normal employment and build up industrial activity of normal kind. Its recovery influence should therefore be cumulative instead of swelling the unemployment roll as does the WPA process. Canada's campaign will probably be helped by the revival of our PWA, since the two countries are more closely related in their economy than in their political systems. In any event the outcome should give further evidence on how effective public works can be made in leveling out depressions in the economic curve.

Little Rivers Again

MORE CONFUSION is added to the issue of federal versus state control of minor streams by the changes made in the flood-control authorizing bill in the Senate last week. A virtual declaration of federal ownership and control was embodied in the bill by providing that the federal government is to pay for reservoir lands and easements and hold title; the plain inference is that the government thereby will come into absolute ownership of the waters and will control their utilization for power and for down-stream use. Since no such right of ownership and control was transferred from the states by the Constitution, there may be many lawsuits before the full effect of the new provision is known. Conference between Senate and House will probably not clear up the bill before it is passed, and apparently a subsequent Congress, more straight-thinking and less disposed to centralization than the present one will have to straighten out the matter. The pending bill does not hold out promise of early flood-control progress. Meanwhile, flood hazards accumulate.

Building in Sand

HOW TO BUILD solid and stable structures of sand is an ancient problem, full of difficulties and disappointments. Nature has shown that it can be done; many natural sand deposits prove that every kind and grading of sand can be made into a solid, stable and fairly watertight structure. But man's efforts often have been less successful, as attested by the records of trouble with foundations and embankments.

Practical trial of sand compaction methods at Franklin Falls damsite throws light on one of the difficulties, confirming and applying what was worked out two years previously in the laboratory. The Harvard work of Prof. Arthur Casagrande in 1935 showed that a mass of sand "loosely" deposited is apt to be unstable, while the same mass forced into tighter packing is stable. In the compacted mass the grains interlock, as in good rubble or firm macadam; in the "loose" mass the grains largely make contact by point bearing and are easily disturbed, which means settlement, slides or other readjustment.

In a foundation bed loose packing does little more than cause settlement. In dams and other structures saturated with water it gives rise to more serious difficulties. When one walks on a sand beach, the sand just above the receding tide is found to be firm at first, but it becomes soft and "quick" under repeated footsteps. The reason, long known in general terms, is that the sand as rearranged by ripple wash has "loose" structure, easily changed to closer packing by the tread of the foot. But such readjustment means that some of the water in the interspaces must be forced out. During its outflow it acts as a separating and lubricating film between the grains that makes the mass mushy and treacherous. A sand levee or dam is subject to the same effect when "loose" in structure; the water-filled interspaces tend to become smaller when any disturbance or shock kicks the grains out of their unstable arrangement, and in this process the sand can easily be converted into a soupy mass.

Prof. Casagrande showed the reality of this effect by building two model dams of a uniform sand, one of them well packed, the other loosely deposited. Both dams appeared stable and held the reservoir of water back of them when undisturbed, but when shaken by an arrangement simulating earthquake action the dam of loose sand promptly melted and collapsed, while the dam of compact sand remained unaffected.

Fortunately most natural sands are well graded and pack rather tight even when deposited at random. Compaction is not unimportant even with these sands, especially as to settlement and leakage; but it becomes vital when a very uniform sand must be used. At Franklin Falls the local valley deposits were exceptionally uniform in their grading, and this was the condition that led to the valuable tests now recorded. By showing how to produce a well interlocked mass, one that cannot be shaken into a "quick" state, the tests proved that a thoroughly stable and safe dam can be built of this uniform sand.

Every type of work done with sand is helped by this finding. The greatest value of the tests, however, lies in the better understanding they give of the structure and behavior of sand, especially as related to water action. Practical use of this understanding can be made profitable in every sand moving or filling operation, from the placing of abutment backfill to the construction of a dam.

The unexpected compacting efficacy of heavy crawler-tractor equipment found at Franklin Falls is also a valuable practical teaching. Those in charge of the work attribute the effect as much to the vibration and tractive push of the crawlers as to the pressure of their weight. As the same actions doubtless have similar importance in compacting graded sands and sand-loam-gravel mixtures, the tests should lead to better assured practice in all types of soil compaction.

Dependable Equipment

LIKE ALL MANUFACTURING operations, concrete mixing requires an adequate and dependable supply of raw materials. Usually, stockpiles of aggregates and stacks of sacked cement near the mixer meet this requirement, but when such storage is not possible recourse must be had to some means of mechanical materials handling. In such cases the job progress is completely at the mercy of the equipment transporting the raw materials, be it trucks, tractors, pumps, bucket elevators, belt conveyors or an aerial tramway.

Manufacturers can take pride and others should accord them credit for the dependability that they have built into their machines. As one example, at Conchas Dam, described last week, every operation is keyed to unquestioned functioning of an aerial tramway, for only if it operates can the mixer get its aggregates from the stockpiles two miles away. And steady operation requires efficiency in a variety of parts—electric motors must function flawlessly, bearings must not break or wear, lubrication must be long-lived and efficient, cables must give continuous service, automatic trips must not jam or fail to operate.

Day after day, on construction jobs the country over, equipment of various kinds is furnishing this kind of steady operation. Efficiency is a word often used in this mechanical age. More than anything else, efficiency on a construction job means dependability of equipment.

PICTURES IN THE NEWS

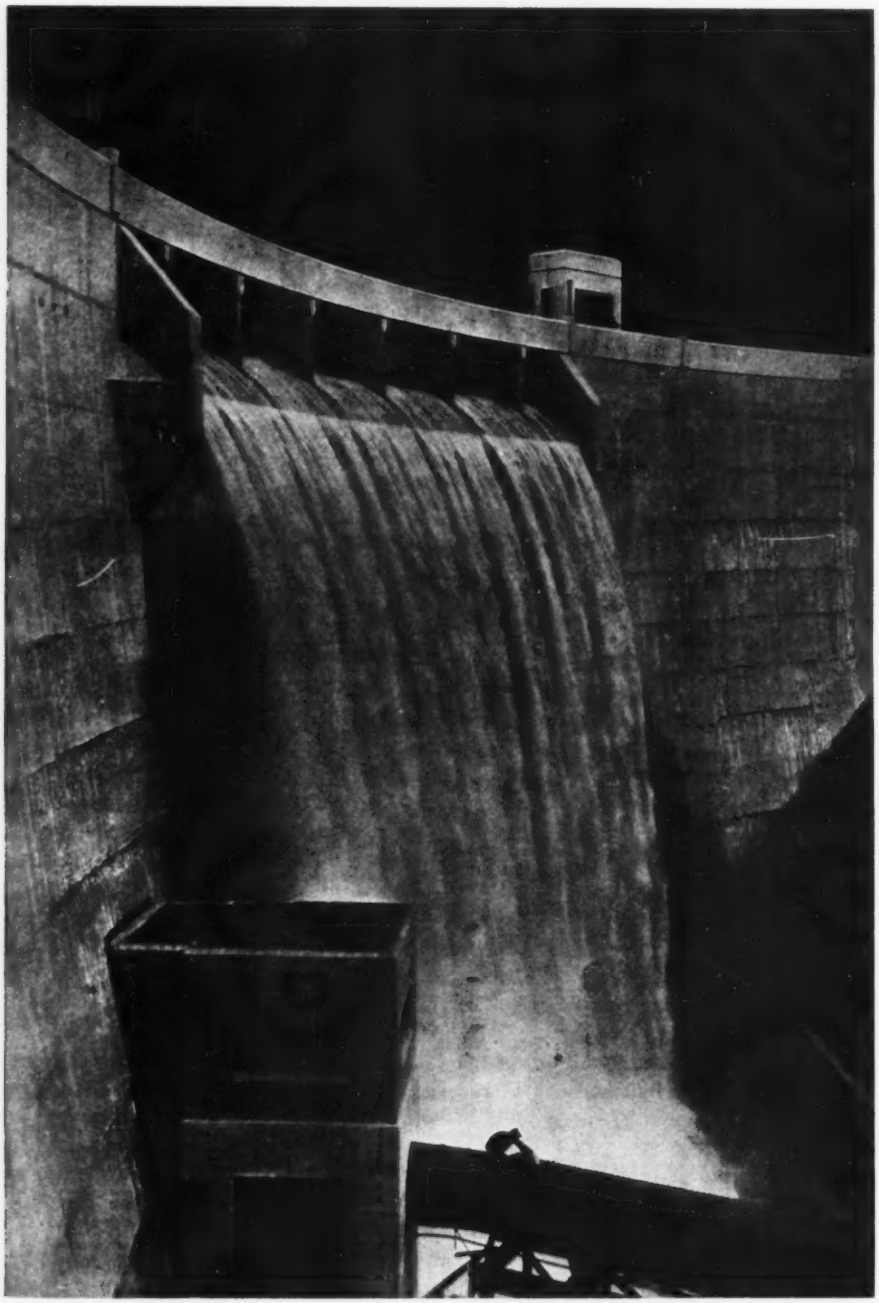

Photo by R. A. Moncrieff

TOWNES DAM on the Dan River, which was dedicated June 7 as a part of the Pinnacle Hydroelectric Development of the City of Danville, Va. It is 133 ft. high and 575 ft. long. Through the pipe line in the foreground water passes to a 11,250 kva. power plant 8,900 ft. away, and 706 ft. below the reservoir.

FIG. 1. TRAVELING RESEARCH LABORATORY USED ON TEXAS TEST ROAD.

Texas Tests Clay Subgrades

JULIAN MONTGOMERY
State Highway Engineer, Austin, Tex.

Elaborate test road brings promise of clearing up conflicting experiences with concrete pavement warping and heaving on clay subgrade

ABOUT 1928 it was observed that surface irregularities had developed in some of the highway pavements in Texas to such an extent that they were becoming a menace to traffic. Investigations toward determining the causes of the irregularities were immediately started in different parts of the state by field engineers. These first investigations resulted in many different theories of the causes. The phenomenon was first attributed to the design and construction of the pavements. Later it was realized that there were other contributing factors, including the type of the substructure soil upon which pavements were placed. With regard to concrete pavements, measurements showed that the ends of slabs at joints and cracks had risen above their original elevations and produced longitudinal warping but that this warping was found only on certain sections of certain highways.

Observations and comparisons of data from different parts of the state revealed four things in particular: (1) No irregularities had developed on sand-soil substructures; (2) the warping had occurred on clay soils (but not at all places where clay-soil substructures existed); (3) most of the surface irregularities had developed in hill cuts and on hill slopes and crests; (4) less warping had occurred in the upper Gulf Coast Plain section than in other parts of the state. The need of a planned study was indicated, and in 1932, with the approval of the state highway commission, the Texas state highway engineer initiated a research project providing for special designs to be built, observed and studied in minute detail. From its inception the district engineer, U. S. Bureau of Public Roads, and his assistants were sympathetic advisors and gave full cooperation.

Location and design

After a careful reconnaissance of the areas in which concrete pavement had warped, the 13½ mi. of new pavement to be built on U. S. Route No. 90 between the Bexar county line and Seguin, in Guadalupe County, was selected for the research work. The selection was made principally because the substructure soil throughout the entire length of the project was nearly all clay of the A-7 type; also on a nearby highway with a similar clay-soil substructure and a 9-6-9-in. concrete base with a 1-in. bituminous surface, warping had occurred within nine months after the completion of the pavement.

The 13½-mi. highway was divided into 37 test sections about 1,180 ft. long, with a regular section at each end of the project. There were no available data upon which to base the designs of the different test sections; the designs finally adopted were based primarily on technical analyses and on practical experience in Texas. To prove or disprove opinions formed by different engineers prior to 1932, some of the test sections were designed as nearly as possible, similar to roadways where surface irregularities had developed in the pavement, and other sections were designed similar to roadways where the pavements had continuously retained their smooth surfaces. The remaining sections embodied different ideas for eliminating the troubles in question.

Fig. 2. **Expansion joint width was measured at determined intervals in coordination with air-temperature and other observations.**

Fig. 3. **Soil-classification samples, over 1,500 of them, were taken on the subgrade before the pavement was laid.**

The concrete design adopted was the regular Texas mix of 5 sacks of cement and 29 gal. of water per cubic yard of concrete, but on some sections this design was modified for special reasons. The slab lengths between the poured expansion joints were 78½ ft., generally, with one dummy joint half way between expansion joints. To eliminate as many unnecessary variables as possible, ponded-water for curing the concrete pavement was adopted.

The general information sought was, first, whether warping in the pavements was caused by the design and construction of the pavement proper, and second, ways and means of overcoming the developing of irregularities in pavements. It was thought that if the trouble was found to be in the soil substructure then the knowledge gained could be applied to other types of pavements.

The principal factors embodied in the design of the different test sections were as follows: (a) Base and subgrade design variations, (b) concrete design variations, (c) length of slab variations, (d) reinforcing steel variations, (e) thickness of slab variations and (f) waterproofing the bottom and sides of the slabs.

Planned observations

One of the paramount objects in the preparation of the schedule of observations to be made was to record all physical data that might in some way have a bearing on pavement movements. It was thought preferable to have in the end data not needed rather than to find that certain omitted observations were necessary to draw definite conclusions. The schedule of detailed data to be compiled consisted of the following field investigations coordinated with laboratory analyses:

1. Description of construction methods.
2. Paving construction progress data.
3. Soil substructure moisture contents.
4. Class and characteristics of the soil substructure.
5. Progressive vertical movements of the pavement.
6. Longitudinal creep of pavement slabs.
7. Progressive pictures of construction methods and observations.
8. Concrete design and strength data.
9. Detailed cost data.
10. Fluctuation in widths of expansion joints.
11. Meteorological data.
12. Slab and subsoil temperature fluctuations.
13. Progressive slab condition surveys.
14. Miscellaneous data.

Grading and drainage were performed in 1932, and the pavement was laid in 1933. Before the pavement was laid on each test section, soil-classification samples were taken from different depths in the substructure and tested in the laboratory. These soil samples were taken at specified points in each test section, and also at points where it could be seen that the type of soil changed. A total of 1,500 soil-substructure-classification samples were taken and tested.

As a means of determining subsequent moisture-content fluctuations

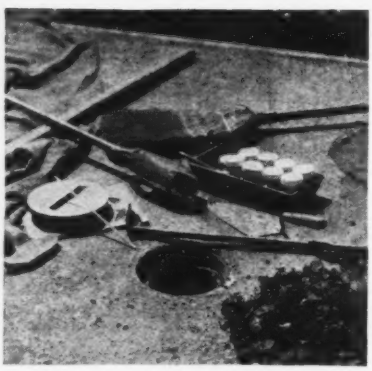

Fig. 4. **Soil moisture-content samples were taken, after paving, through covered and steel-lined handholes installed in the pavement slab.**

Fig. 5. **Bench marks along the road 10 ft. outside the pavement edges enabled accurate leveling and measurement of changes in slab heights.**

in the soil foundation on the various test sections, samples of the soil were taken at specific points and from different depths below the bottom of the pavement, immediately before concrete was poured, and were tested in the laboratory. During the pouring of the concrete, 6-in. diameter iron handholes with water-tight covers were set in the pavement at the points where the moisture-content soil samples were taken. Subsequently, samples were taken through these handholes from time to time until October 21, 1936. A total of 25,000 of these samples were taken and tested. Soil-moisture-content samples were also taken from under the pavement at different distances from expansion joints, before and after concrete was laid, to determine the amount of wetting of the soil, caused by leakage of the ponded curing water through joints and at the edges of the pavement.

Pavement movements checked

To determine the amount of vertical movements in the pavements after it was laid, well protected bench marks that extended several feet into the ground, were set ½ mi. apart along the edge of the right of way. Lighter bench marks, used for turning points, were set 250 ft. apart. A reversible micrometer level, protected by a sunshade, was used for determining the elevation of the pavement when it was completed and at different times thereafter.

To determine temperature fluctuations in the top of the concrete pavement, in the bottom of the concrete pavement and in the underlying soil, a 3-bulb continuous recording thermometer was employed. Brass tubes were installed in the pavement on several test sections at 1 in. below the top of the slab and 1 in. above the bottom of the slab. A thermometer bulb was inserted in each of these two tubes; the third was usually placed in the soil under the slab.

Continuous intensive observations were made from the beginning of construction of the pavement on March 6, 1933, to its completion on Sept. 21, 1933, and on the behavior of the pavement until Oct. 21, 1936. The data recorded during this time are divided into four reports the last of which is nearly completed in printed form.

Fig. 6. A piano wire pulled taut across opposite bench marks enables a man to scale changes in the transverse profile of the pavement.

Because of the large volume of data recorded, much study and time will be required to draw definite conclusions on all of the reactions which have occurred on the project. Even though it is impracticable at this time to draw detailed conclusions there are some outstanding phenomena to which attention should be invited. The foremost relates to draining gravity water from the soil substructure, which is described in the article on the following page.

Asphalt mat protection

Attention is invited to a section where the entire crown of the clay soil substructure was covered with a mat of asphalt 48 ft. wide. The concrete pavement was placed directly on the asphalt, and the asphalt on the roadway shoulders was covered with clay soil to the top of edges of the concrete slab. Where sand or other granular material is not available for covering the soil substructure, the result shows that some durable waterproof mat of processed material may be employed to serve the same purpose. It was also observed that asphalt from the mat rose into the joints and cracks in the pavement during hot weather and kept the joints and cracks sealed.

Attention is also invited to a test section, where the contraction or dummy joints were spaced 10 ft. apart. This pavement was laid directly on the native clay soil and the roadway shoulders were built of the same material. Tests have never revealed leakage of water through the pavement joints on this section. No cracks have yet been found in the concrete, and the pavement has retained a comfortably smooth-riding surface.

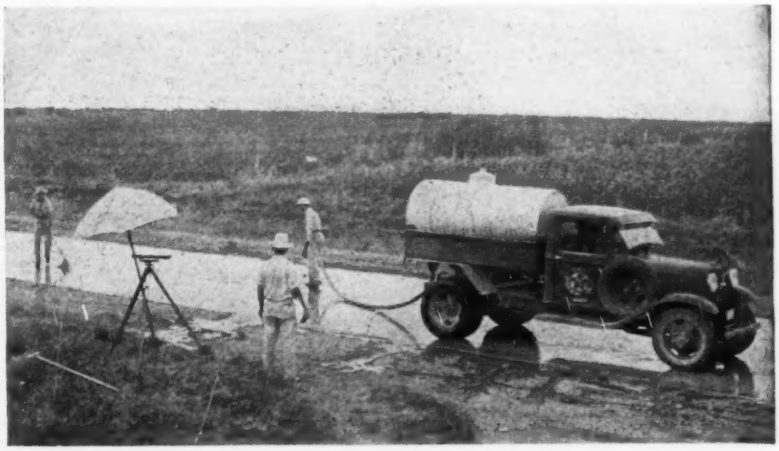

Fig. 7. A piano wire pulled taut across opposite bench marks to enable a man to scale height or warping was tested by taking levels on pavement drenched with water on a hot day.

Roadbed Design For Self-Drainage

H. C. PORTER
Engineer of Research, Texas Highway Department, Austin, Tex.

Designed location of soils of different permeability in roadbed and fill eliminates major hazard of gravity water to highway surfaces

IT HAS long been known that most failures in soil structures of both railways and highways are caused by water and that the paramount factor in proper design is adequate drainage. In the past, adequate drainage has been thought of as principally surface drainage, rapid movement of storm water from the side-ditches to the creeks. It is now realized that proper facilities must also be provided for draining gravity water from the interior of the soil substructure. Almost any clay soils will, without appreciable movement, carry loads transmitted to them by the road superstructures if the soil constantly remains dry. It is impracticable, however, continuously to prevent all water from entering the roadway structure; both capillary and gravity water will eventually reach the soil, and so drainage becomes an important consideration.

Water does more damage to clays than to coarse-grained soils and the greater the amount of water a clay soil absorbs, the more unstable it becomes. This has been common knowledge for many years, but the main reason no more progress has been made toward retarding gravity-water wetting of the soil is because it was generally thought that the greatest damage was caused from capillary water moving up into the soil substructure and there was no praticable means of preventing it. Tests made in the Texas State Highway Department soils laboratory, with clay soil classed as A-7 (BPR) show that there was much more wetting of the embankment soil, by gravity water (from simulated slow rain) than by capillary moisture from water impounded at the toe of slopes of the miniature embankments. These tests indicate that if gravity-water wetting is reduced to a practicable minimum in the field, the capillary moisture will, in many instances, do no appreciable harm.

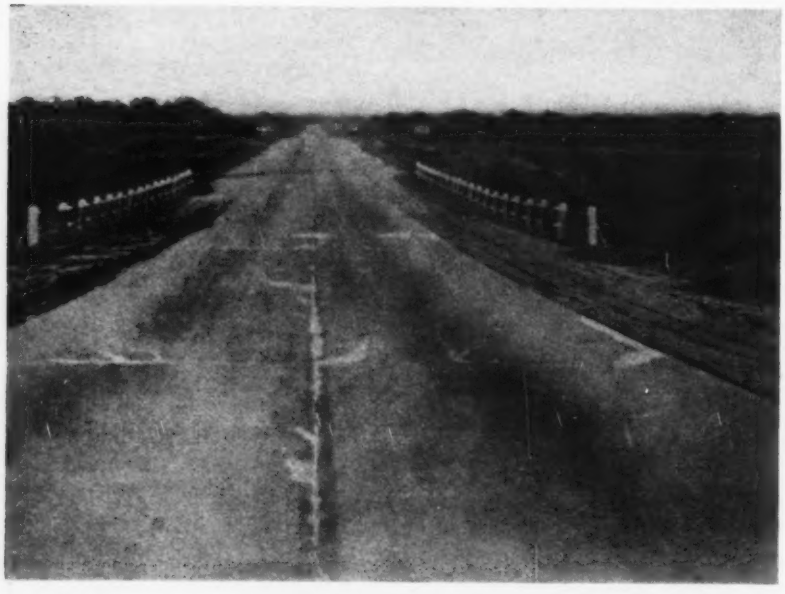

Fig. 1. Water seepage through the joints in a pavement laid in a trenched clay subgrade showed plainly on the surface.

From the broad viewpoint, soils are divided into two major classes, pervious and impervious. The coarse sands and gravels are the pervious; the fine-grained clays are the impervious; and the silts and fine-grained sands are on the border between the two. When water, such as rain, falls on the coarse-grained materials, it permeates them, regardless of whether or not the surface of the material slopes or whether the materials are compacted. When water falls on a sloping clay-soil surface, the tendency of the water is to run down the slope rather than to permeate it. The more compact the clay the less permeation there is. But, when water is impounded on clay soil, the water will eventually permeate it (from capillary action mostly) and will cause the clay to expand and become plastic or soft. Moisture content fluctuations in undisturbed coarse-grained soils do not cause appreciable volumetric change or plasticity in the soil. Sand, as found on the beach, is more stable when wet than when dry.

If the coarse-grained materials in the roadway soil substructure slope to intersections with the roadway side-slopes, the gravity water will drain away before it has time appreciably to permeate the underlying and adjoining clays. But when coarse-grained soils rest on and are flanked by impervious clay soils, rain water will completely fill the large voids in the coarse-grained material, and there will then be gravity water impounded on the clay soil.

Proof by examples

Demonstration of the effect of this pocketing of water is given by data taken on two adjoining sections of an experimental project built in Texas in 1933, designated hereafter as Section A and Section B. They were designed and built alike in every respect except that the 12-in. depth of sand, as shown by Fig. 2A extends entirely across the crown of the clay soil-substructure, to intersections with the roadway side-slopes; while the 12-in. depth of sand, as shown by Fig. 2B was placed in a trench cut in the top of the clay soil-

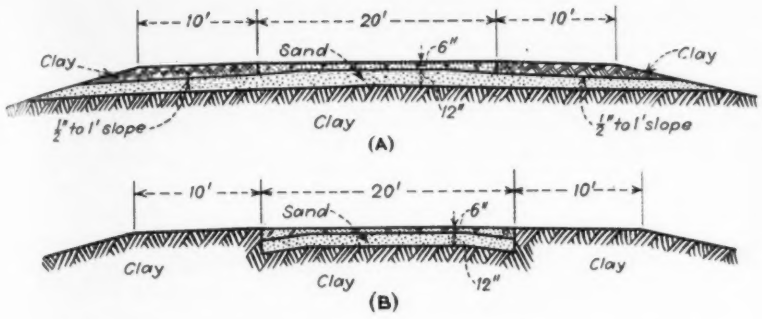

Fig. 2. Two types of sand base for concrete pavement on clay subgrade.

Fig. 3. Pavement on black waxy gumbo soil with granular base material extending entirely across the roadway to intersections with the side-slopes.

Fig. 4. Rainwater impounded by the tight clay soil shoulders at the edge of gravel base material placed in a trench cut in tight clay soil.

substructure. A 9-6-9-in. concrete pavement, 20 ft. wide, was placed on the sand on each section and the shoulders were built up to the top of edges of pavement with native clay soil. On Section B, after completion of the pavement, a French drain was built alternately right and left at the expansion joints but the drains did not function.

After a long period of slow rains in 1934, it was noted that water seeped through contraction joints to the surface of the pavement on Section B, as shown in Fig. 1. This occurred after slow rains in June, 1935, and again in February, 1936. No seep water was ever found on the pavement surface of Section A. On the other hand, after each of these rain periods, it could be seen that water was draining from the sand to the roadway side-slopes of Section A.

On June 18, 1935, when the view Fig. 1 was taken, a hole was dug at the edge of the pavement down to a few inches below the bottom of the pavement. As soon as the hole was excavated to below the top of the sand under the pavement, water immediately flowed from the sand into the hole. At the same time a similar hole was dug at the edge of pavement on Section A. No free water appeared in this hole during the one hour's time it remained open.

Moisture content samples were taken from each of the two test sections on or about the same days. By comparing these it was found that the soil moisture contents on A were lower than those on B. During the past five years no appreciable riding surface irregularities have developed in the pavement on Section A, while uncomfortable riding surface irregularities have developed on Section B. In 1934, four cracks had developed in the concrete on Section A and three on Section B; in 1937 there were 13 on A and 14 on B.

The subsequent beneficial effects of extending coarse grained material to intersections with the roadway side-slopes, when placed on highly expansive and plastic clay soil, are illustrated by Fig. 3. Ill effects produced where coarse grained material on the soil substructure is flanked by impervious clay soil are shown by Fig. 4. The line of least resistance to movement of this water is into the granular base material, instead of draining through the shoulder soil, to the side-slopes and ditches.

Construction of the project, shown by Fig. 3, was completed in 1932, while the project shown by Fig. 4 was completed about 1930. The pictures were taken on both projects in 1935. In 1937 there was practically no change in the condition of the former, while the latter project had developed additional riding-surface failures. The substructure soil on both projects is of practically the same type, black waxy clay. The base material of the former is crushed rock; that of the latter is gravel. Observations made on other projects substantiate the conclusion that the great difference in the behavior of the riding surfaces on these two projects is not due to the difference in the base materials used.

Soil design a cure

The necessity for the proper draining of gravity water from subbases and bases is now generally recognized by highway engineers; but in many instances they fail to realize that adequate provision for draining gravity water out of the entire man-made soil substructure is also important. Where heterogeneous materials are promiscuously placed in the fills, just as they happen to come from the hill-cuts, sideditches and borrow-pits, pockets of coarse-grained materials will be formed in the soil substructure, where gravity water will eventually be impounded on clay soils and cause them to move from time to time. No doubt there are many phases of soils mechanics that must be taken into consideration in the proper design and construction of the roadway soil substructure, but this item of adequate drainage of gravity water from within the soil substructure is prerequisite, and at present, will do more toward stabilizing the entire roadway than any other one item, regardless of whether the project be a primary or secondary road, and regardless of the type of pavement.

When a road is to be built through a section of country where the natural formation is heterogeneous and the different types of soils that will

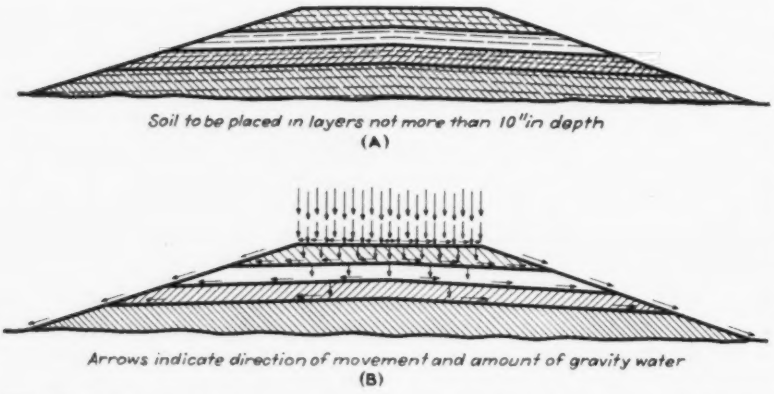
Soil to be placed in layers not more than 10" in depth
(A)
Arrows indicate direction of movement and amount of gravity water
(B)

Fig. 5. Soil in fills graded from impervious at the bottom to pervious at the top ensures proper drainage.

be encountered and used in the soil substructure are not predetermined, it is impracticable during construction to place the soils so that pockets of coarse-grained materials will not eventually impound water. The soil profile must therefore be drawn during the location survey, and used in the proper design and preparation of the plans and the haul diagrams.

When pervious material is to be placed on clay soil, the top of the clay soil should first be made to slope continuously from the roadway center-line to intersections with the side-slopes. Generally, the most highly expansive and plastic clay soil should be placed at the bottom of the fill where it will be protected most from gravity moisture-content fluctuations; the next most expansive clay on it, and so on until the most pervious and non-expansive soil is placed at the top of the fill, as shown in Fig. 5A.

When the embankment is constructed, as above described, the movement of gravity water out of the soil substructure is illustrated by the arrows in Fig. 5B. This method of construction will not only retard volumetric changes in the roadway structure during extreme wet weather and during droughts, but will reduce frost boils in regions where frost is a factor to be considered.

Plant Improvement Prepares For Increased Demand

Westinghouse finds period of light load favorable for carrying out program of bringing production facilities up to full efficiency

PLANT EXPENDITURES amounting to 12 million dollars announced by the Westinghouse Electric & Mfg. Co. for the current year are stated by A. W. Robertson, chairman of the board, to be necessary to remove bottlenecks in production. While these bottlenecks were discovered during the time of heavy demand a year ago, through their effect of making full use of manufacturing facilities impossible, the present time is considered specially favorable for making changes that will eliminate the obstruction, as plant changes are difficult and expensive when the plant is busy.

Mr. Robertson's statement of the reasons for planning the present program, given in answer to an inquiry from Engineering News-Record, is as follows:

"The Westinghouse Electric and Manufacturing Company is planning to spend some $12,000,000 this year on improvements and betterments for the following reasons:

"Last year we had more business than we could take care of promptly with our facilities. We found that at certain points in the process of manufacture, there was a block on the line which effectively prevented the full use of other facilities. It is common for us to refer to these points as bottlenecks, meaning manufacturing goods were delayed in getting through these particular points. As a result of this experience, we studied our facilities and ways in which they could be best improved.

"As a result of this study, we decided on the improvement and expansion program referred to. The work could be likened to improving the approach to a bridge so that the traffic could cross the bridge without delay, as distinct from building a new bridge.

"It is hardly necessary to add that we think we will have some need for these improved facilities in the relatively near future, otherwise we would not be spending the money.

"A part of the money will be spent in the usual course of maintaining the property in first class condition. This must be done in bad as well as good times.

"We have also learned that the time to change and improve manufacturing facilities is during a period of light load, as it is very difficult and expensive to change them when the plant is busy."

The year's expenditures for plant improvement, which are about equal to those of 1937, are distributed over the company's plants in many states, from New England to California. While the improvements in 1937 were mainly of expansion character, to keep up with rising demand for production, the current program is one of removing bottlenecks, as stated, and is based on the belief that business conditions will improve and that plant must be ready for increased production.

Improvement is to be made in practically all departments, including lamp, meter, elevator, transformer, motor and radio divisions. Machine tools and other equipment represent about 5 million dollars of the total.

CRANE ON FIRST FLOOR RUNWAY ERECTS HIGH TRUSS BENTS

Crane Climbs Into Building To Erect Steel Framing

G. C. OLSEN,

Production Manager, St. Joseph Structural Steel Co., St. Joseph, Mo.

Erector resorts to novel expedients to strengthen crane boom in erecting columns and high trusses

THE STRUCTURAL STEEL frame for a new chapel building at Mt. St. Scholastica's Academy in Atchison, Kan., was erected recently by the use of a ½-yd. crane mounted on a timber runway built along one edge of the first floor slab. The crane climbed to the runway under its own power over a ramp constructed of heavy timbers cleated together and supported on cribbing. The ramp grade was about 25 per cent. In order to reach the high steel work the crane was equipped with a 52-ft. boom of a capacity considerably greater than it could handle unaided, and an 8-ft. extension was added so the overall length between pin centers was 60 ft.

Factors which led to the use of the crane on the runway in the building were lack of available storage space for the steel other than on the slab itself, a side hill location accessible from one side only, and the fact that the main steel columns were supported at first floor level, some 6 to 10 ft. above surrounding grade. As these columns were set back 8½ ft. from the outer walls, a shelf was available for the runway construction.

The outer edge of the runway was carried by 12 x 14-in. timbers supported in part by concrete piers and walls below the floor slab and in part by 12-in. timber posts, resting on the wall footings. The inside edge was carried on 8-in. 31-lb. H-beams having a 6 x ½ in. cover plate welded to each flange. The H-beams were cut sufficiently short to permit erection of the steel columns and had about 4½ in. of bearing over the concrete piers which supported the columns. Two lines of 3 x 12-in. floor plank spiked to cross ties provided a running surface for the crane.

Operating on the runway, the crane unloaded and distributed the major steel items (columns and half-trusses) over the floor slag according to a predetermined pattern. The erection plan provided for the row of 35-ft., 3,500 lb. columns on the far side of the structure to be erected first, but setting them required a horizontal boom radius more than sufficient to have caused overturning of the crane. To prevent this a 40-ft. pole was set up as a shore under the boom about 4 ft. back from the outer pin and attached so that the load would be transferred from boom to pole. The pole was also tied to the boom with short lengths of cable so that it could be swung with the boom from column to column. During the raising of the columns the boom was guyed laterally to prevent side sway.

An arrangement similar to the foregoing was used for erecting the trusses which (after the two halves were riveted together on the floor) presented a top-heavy erection piece 11 ft. deep at the center, 23 ft. deep overall and weighing some 4 tons. Erection of a truss was a two-stage operation. First, it was lifted from the floor slab into a vertical position ready for hoisting and guyed while the crane erected the near-side column for the truss support. Then, as the second stage, a 50-ft. pole was set up behind the truss with its base resting over a floor pier and its top attached to the boom which was swung into exact position for raising the truss and guyed laterally. After the pole guys had been tightened and with the pole shoring up the boom, the truss was hoisted into place. Correct positioning of the boom was imperative since, once the truss was in the air, it could be shifted only by the play in the guy ropes.

This method of erection because of the constant danger of accident is not recommended where other means are available.

The architects on the building were E. Brielmaier & Sons Co., Milwaukee, and the general contractor, J. E. Dunn Construction Co., Kansas City, Mo. The steel was fabricated and erected by the St. Joseph Structural Steel Co., St. Joseph, Mo.

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Historical Maps of Country Authorized by Congress

THUMB-NAIL SKETCHES of United States history, showing the development of the country from its earliest Colonial days, are being assembled by the U. S. General Land Office into a comprehensive official government map of the nation and its outlying possessions. Estimated to require six months in reproduction, the new map has been ordered by Congress in accordance with the program for issuance of an up-to-date chart of the United States every two years. The map will be 7 ft. long and 5 ft. high, drawn to a scale of 37 mi. to the in.

Power From Refuse Incinerators

FRANCIS C. HOLBROOK
Mechanical Engineer, Department of Sanitation, New York

Better combustion control through the use of shredded refuse and furnace feeding devices will aid in the production of power

ONE of the fundamental differences between the use of commercial fuel and combustible municipal refuse for the production of power lies in the manner of controlling the combustion of these fuels with load variations. In most incinerator plants where power is a byproduct of the destruction process, no attempt is made to vary the feeding of furnaces with steam demands due to the urgency of immediate destruction and because of the irregular fuel value of raw garbage and rubbish. Therefore it is possible to utilize only a part of the products of combustion for power purposes, air preheating, etc., with the remainder wasted to stack. This is particularly true in large plants where many furnace units are used, and where incinerator gas production is in excess of the power requirements.

Before the potentialities of power production from refuse can be fully developed, however, it will be necessary to improve incinerator performance. Toward this end, better combustion control must be considered.

Combustion control as practiced in commercial power plants can be simulated in a waste-heat incinerator plant if the refuse is reduced to a uniform product with its moisture and combustible constituents evenly distributed throughout the mass. The efficiency of combustion can also be increased by eliminating inert materials such as metals, glass, and similar incombustibles.

Another important advantage of combustion control in incinerator operation is the limitation it places on wide fluctuations in gas temperatures, an undesirable condition which occurs in the batch feeding of hand-fired furnaces. Elimination of extremes in temperature fluctuations reduces maintenance costs on furnace linings.

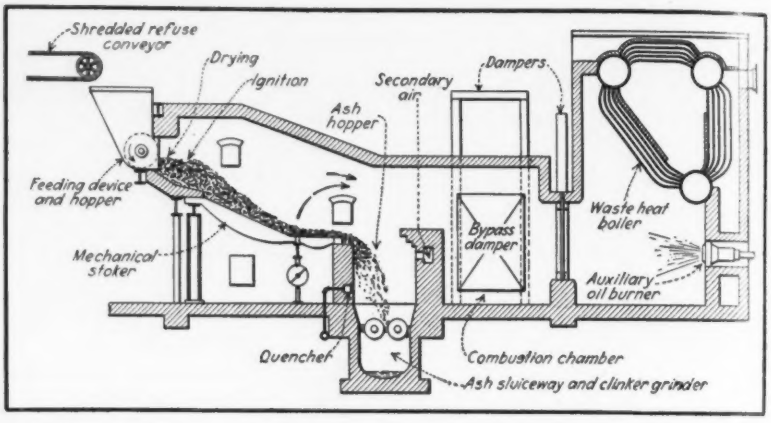
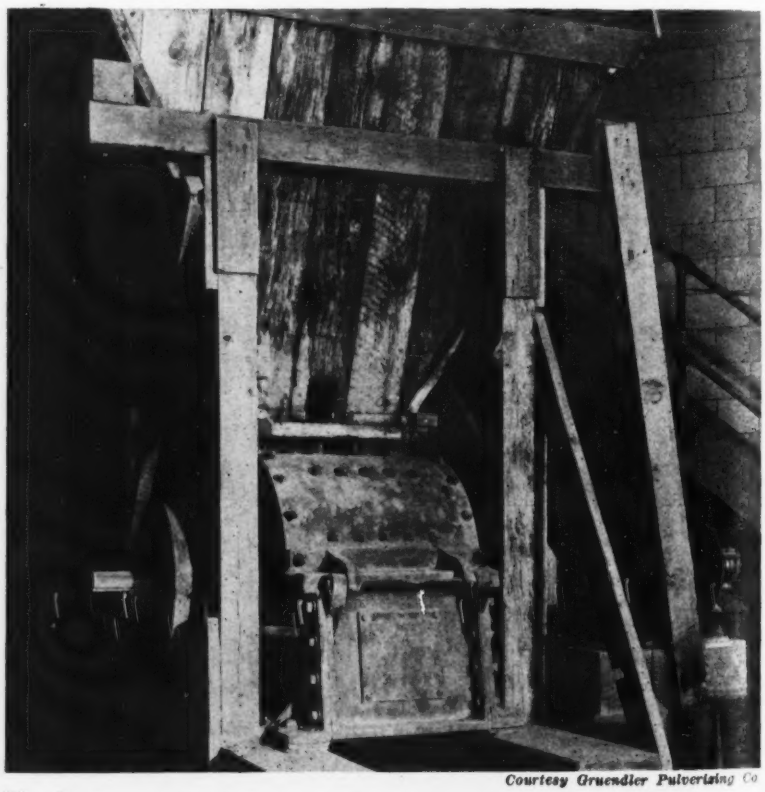


Fig. 1. Typical layout of a refuse incinerator equipped with mechanical feeder and stoker designed for power production



Courtesy Gruendler Pulverizing Co

Fig. 2. Hammermill grinder fitted with a temporary wooden hopper used for refuse incineration experiments

Some attention has been directed to the possibilities of hogging or shredding municipal refuse previous to its combustion on mechanical stokers. In this connection it should be recalled that for many years industrial wastes containing combustible elements have been hogged and burned in various types of furnaces; such practice has resulted in large savings in fuel costs. In one instance this material was burned under waste-heat boilers which were allowed to "float" on the main header with the combustion control being attached to the main power units.

Selection of burning devices

The selection of equipment best suited for preparing and burning hogged municipal refuse will very likely be determined from tests now under way in several cities. Manufacturers of incinerator equipment are apparently loath to enter this field until some progress has been made. One scheme provides a hammermill hogger and equipment for blowing refuse into a furnace on the order of pulverized coal. Another delivers the hogged refuse through the arch of a waste heat boiler where part of the combustion is in suspension and the remainder on the grate surface. Still another delivers refuse by conveyor to a furnace equipped with a mechanical stoker.

There are two types of mechanical stokers generally adapted for firing hogged refuse. These are the inclined stationary or moving grate, and the horizontal chain grate type. The inclined grate has been used in the sugar industry for burning bagasse (which runs fairly high in moisture content) and in plants burning wood wastes. In incinerator furnaces it is preferred to the horizontal type because of the agitating effect produced by the moving grate bars along the entire fuel bed. This agitation is important in limiting the clinker formation when burning at high temperatures and besides, when accompanied with the cascading effect, assists proper combustion.

Experiments in feeding

The development of furnace feeding devices offers a wide field for experimentation. Among other things the dangers of pre-ignition in partially dried material, variable feed-

Fig. 3. Stoking an incinerator furnace is a difficult hand labor operation the elimination of which will depend on the success of present experimental work

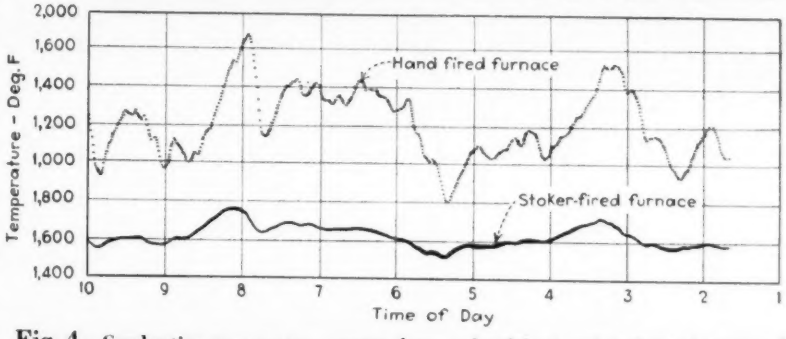


Fig. 4. Combustion temperature curves from a hand-fired and stoker-fed furnace. The latter maintains a relatively uniform temperature

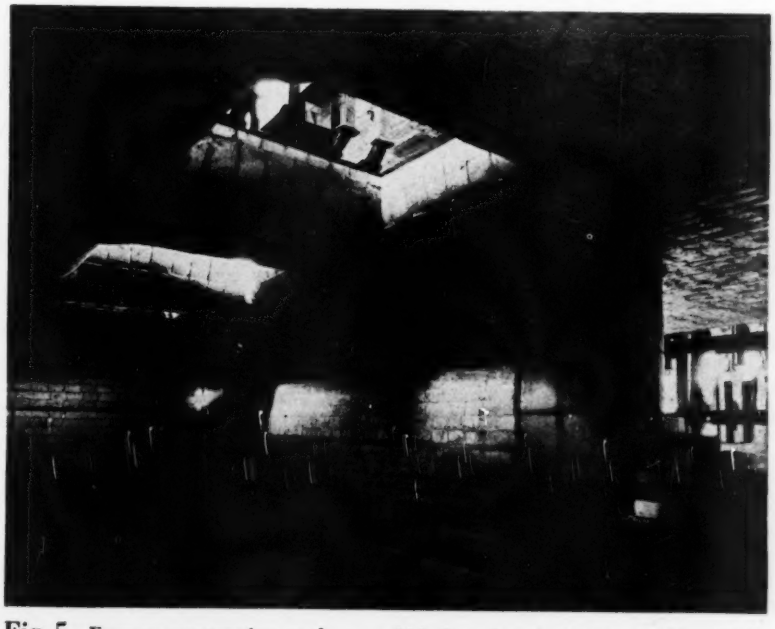


Fig. 5. Furnace construction at the new 56th St. refuse incinerator in New York, showing the refractory lining in place.

ing requirements, and the perfection of a positive seal to prevent the entrance of large volumes of excess air must be taken into consideration. Direct hopper feed such as used for coal firing would hardly be suitable for refuse feeding because of the differences in gravity flow characteristics.

Aside from better combustion control there are other advantages in burning hogged refuse on mechanical stokers. Briefly, these are: (1) The use of a higher combustion rate, thereby reducing furnace sizes; and (2) a saving in cost of refractories because it will not be necessary to use heavy furnace and combustion chamber walls to provide residual heat for the re-establishment of the proper temperature level when moisture-laden materials are fired. Added to this will be the shorter "cooling down" period for furnace slag cleaning and minor repairs; at present a period of 12 to 16 hours is required to cool the refractories sufficiently to permit cleaning and repairs.

Despite the many improvements in present-day incinerator equipment, operation requirements call for a large amount of arduous and demoralizing hand labor. This labor, which is used mainly in charging and stoking furnaces, would be practically eliminated in a plant mechanized for uniform feeding and combustion control. It is through continued experimentation along these lines that further developments can be assured in the utilization of combustible wastes for power production.

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

Service to Kibitzers

Building contractors have during the years constantly improved the good appearance of the safety and guard fences placed around working operations on busy city streets. Neat carpentry, colorful paint and even architectural art are called into service as shown by the fence illustrated. This is the fence that keeps trespassers off the lot in Hollywood, Calif., where the National Broadcasting Co. is building its new $2,000,000 studio. But Hollywood never consciously overlooks its public and so observation balconies were installed in the fence from which any curious or interested persons could watch all the complex operations of modern building work. These had particular attraction in this instance because noise is not wanted where moving pictures are being made and the contractors are using noiseless mixers and hoists, are welding instead of riveting the steel and hushing clang and shouting wherever practicable. Incidentally the paint colors (light brown and green, white and jet black) used on the fence are being thought of for the building itself and the fence gives the customary preview. The contractor is The Austin Company, Cleveland, Ohio.

Observation balcony in contractor's fence around a building operation.

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Pulling Sheetpiles Underwater

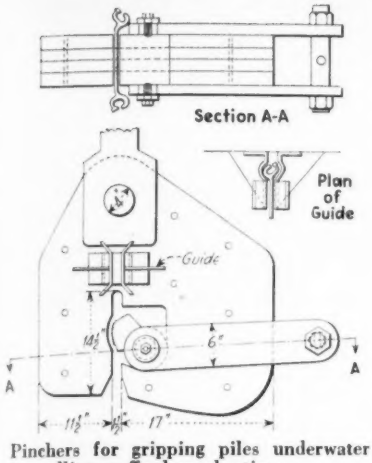
H. L. SCHLUBACH
Larchmont, N. Y.

The job-devised pinchers shown by the accompanying sketch were used in pulling spliced sheetpiles at Grand Coulee dam. Attempts to pull the spliced piles by taking hold of the tops separated them at the splice. The pinchers were designed to take hold of the pile below the splice underwater.

There being some 1½ and 2-in. plate in stock, two pieces of each size were burnt out as shown by the sketch. They were then laminated together with countersunk rivets and by spotwelding some of the joints. The bearing for the cam was then machined and ground. The cam was forged about 12-in. long from a piece of 12-in. diameter stock. After turning it down in the lathe, teeth about 3/16-in. deep were put on the cam with a planer. Two arms of 1½-in. plate 6 in. wide were then keyed to the cam and held in place by a ⅞-in. tap bolt and washer.

To spot the pinchers on the sheetpiling a guide was welded to one side which would slip over the interlock of the adjacent sheet. The guide was so designed that it would fit the interlock no matter which way it was turned and by then lowering away would spot the pinchers on the center of the adjacent sheet.

After being in position, the lever-arm of the cam was pulled upward with a six-part soft line tackle which would press the teeth firmly against



Pinchers for gripping piles underwater in pulling cofferdam sheeting.

the sheeting. Then by starting to pull with the main line of the pulling barge, the cam would grip the sheet tighter and tighter and push the web into the groove thereby locking it in place. Once the cam got hold of the sheet it never let go and only on one or two occasions did the web rip out. To release the pinchers from the pulled sheetpile it was only necessary to hit the leverarm of the cam downward with a sledge but first the sheetpile had to be snubbed off and the main line had to be slacked off.

With dull teeth it would be difficult to get the pinchers started so two identical cams were made which could be interchanged in a few minutes by loosening the stud bolts, taking off the leverarms and sliding the new cam in place of the dull one which would then be sent to the machine shop for new teeth. A cam would last from four to six shifts depending on the number of sheets pulled which would vary from one or two to 15 or 20 per shift.

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Calculating Deflection Angles

JAMES J. RETTINGER
Assistant Engineer,
Allegheny County Works Department,
Pittsburgh, Pa.

To calculate deflection angles for any highway curve for a given radius: Divide the constant 1,718.8692 by the radius to get the deflection per foot of curve in minutes, then multiply the required number of feet of curve by the deflection per foot. This gives deflection angles for actual lengths of curve and not chord lengths. This constant 1,718.8692 is very convenient when highway curves are specified by the radius in even number feet instead of by the degree of curve. The derivation for the constant 1,718.8692 is as follows:

Length of curve — $1/360° \times 2\pi R$
Length of curve — 1 ft.
Deflection angle — $1/2$ I
Deflection angle — $360 \times 60/4\pi R$
Deflection angle — $1{,}718.8692/R$ minutes

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Erector for Precast Wall Slabs

W. C. BROWN
San Francisco, Calif.

The contractor for constructing transit sheds on Piers 9 and 19, San Francisco, used an ingenious movable scaffold or traveler, shown in the accompanying view, for placing the precast concrete slabs of which the side walls of the sheds are constructed.

Lumber carriers and cranes were used to move the slabs, weighing up to about 3½ tons, from the casting yard to points adjacent to the wall, where they could be picked up by the traveler with a minimum amount of horizontal movement. The traveler was supported by a small car on the permanent railroad tracks on the pier aprons, and by a skid which rested on the edge of the roof. Slabs were lifted by two independent lines on hand winches, and any required longitudinal movement was obtained by additional hand winches.

$10 JULY BONUS

THE CONTRIBUTION to the July Field and Office pages considered by the editor of the F & O section to be most helpful to the readers *will win for the author $10 over and above the regular payment for such items.*

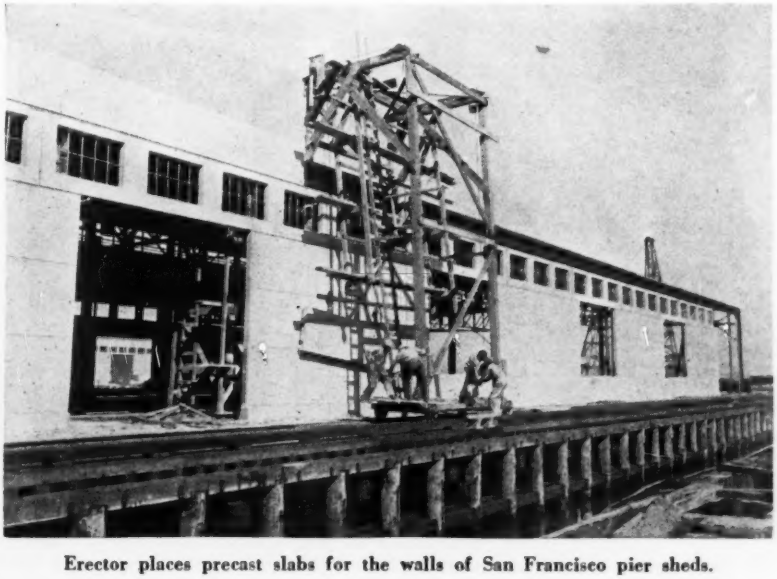
▶All contributions received in the contest and accepted by the editor for publication will be paid for at regular rates.

▶Items to be considered must be received at the editorial office, 330 W. 42 St., New York City between June 27 and July 18.

▶Items must not be over 500 words long.

▶Announcement of the award will be published in the July 28 issue.

The design of the joints between slabs required considerable steadiness and accuracy in lowering the slabs into position, and very satisfactory results were obtained with this equipment. The principal feature of the horizontal joints is a cylinder of mortar moulded around a small roll of wire netting just before placing a slab, the mortar filling semicircular grooves in the abutting slabs after they are in position. Correct spacing was obtained by the use of short wooden cylinders near the ends of the grooves. The vertical joints consist of grooves containing a copper water stop, and the spaces filled with grout.



Erector places precast slabs for the walls of San Francisco pier sheds.

Compacting Cohesionless Material

RICHARDS M. STROHL
Engineer, U. S. Engineer Office, Memphis, Tenn.

Field tests of compaction methods for building a rolled-fill dam of sand gave valuable data on rolling equipment, procedure and moisture content

Fine sand is the only local material available for building a proposed dam for Merrimack River flood control. To forestall trouble from instability of the embankment when saturated, means were sought to compact the sand to "critical density" during construction. In extensive field tests rolling was found better than tamping or vibrating. Best moisture content is just below saturation, best layer thickness 12 in., and best rolling equipment a heavy crawler tractor followed by a sheepsfoot or disk roller. Six to eight passes of the tractor treads over the whole surface of the layer produce the desired density. —EDITOR

WHEN EARTH DAMS must be built in glaciated areas where there is a pronounced scarcity of cohesive materials, the use of cohesionless sands and silt common to these areas must be considered. Cohesionless materials for dam construction have been generally accepted in hydraulic and semi-hydraulic fill dams. When placed hydraulically these materials have a high porosity, and some means of reducing the porosity has been sought. The safety of such dams has been questioned by some authorities, particularly in case of earth tremors occurring when the material in the dams is saturated due to a full reservoir. Recent studies of cohesionless materials in the construction of highway fills and earth dams have indicated that a relatively high degree of stability for these materials can be gained by compacting them approximately to their critical densities.

The term "critical density," proposed by Prof. A. Casagrande of Harvard University, means that density at which a material will not contract in volume when subjected to shearing deformation. If a saturated cohesionless material in an earth dam has a porosity greater than the critical porosity, any vibration or movement of the particles would tend to contract the volume of the fill, but as the volume change is retarded by the water in the voids the load of the fill is transferred from the grains of the material to the water, reducing the mass to an unstable condition. (See "Characteristics of Cohesionless Soils Affecting the Stability of Slopes and Earth Fills," A. Casagrande, *Journal* of the Boston Society of Civil Engineers, Jan. 1936.)

The U. S. Engineer District at Boston, Mass., was faced with this problem in considering the Franklin Falls dam project on the Pemigewasset River in New Hampshire, for flood control of the Merrimack River. Dr. Casagrande was retained to carry on a series of laboratory studies of the critical densities of the material available and to advise on possible compaction methods. Field tests of compaction methods were made with hired labor under the direction of the district engineer. Standard equipment was furnished by manufacturers to make rolling and vibrating tests. Other equipment was constructed for the purpose.

Fig. 1. Bulldozer tractor hauling sheepsfoot roller compacted a test embankment of sand satisfactorily in field tests at Franklin Falls.

Fig. 2. Disk roller hauled by crawler tractor produced good compaction; 12-in. layers and moisture just below saturation were best.

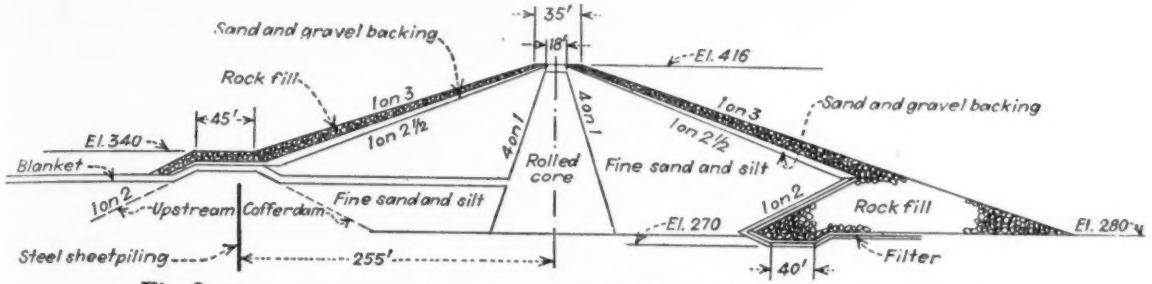


Fig. 3. Fine sand is the material proposed for building the main part of Franklin Falls dam.

The development of an embankment section for a rolled-fill earth dam at Franklin Falls required the use of as much of the cohesionless material from the excavations as possible. The high cost of suitable core material, which must be imported from a distance of 4½ mi., necessitated using as small a thickness of core as would suffice to insure low seepage. The adopted section is shown by Fig. 3, which represents typical details of the maximum section. Laboratory tests show that the section is highly efficient.

The materials tested consisted of a mixture of fine sand and silt (curve A, Fig. 4), a fine to medium sand (curve B), and a third grading (curve C). The materials represented by either curve are quite uniform in grain size and no cohesive material was in evidence in the tests.

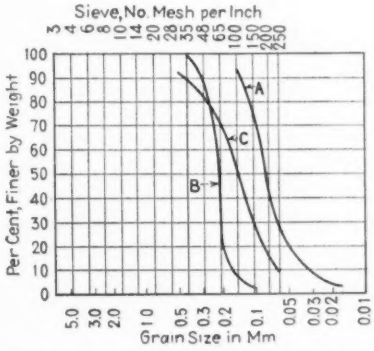


Fig. 4. Fine, medium and intermediate sands (grading curves A, B and C) are available.

Laboratory tests were carried out to determine the critical density required for stability under the assumed condition. For material A the critical density was found to be practically constant at void ratio about 0.61 under varying loads (Fig. 5) except under very light loads. For material B (Fig. 6) the critical void ratio is slightly lower, about 0.60. Evidently, the better the grading,

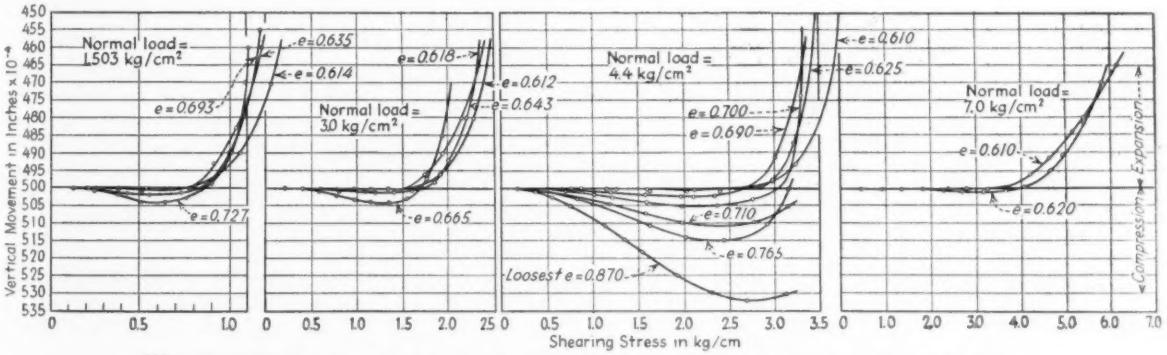


Fig. 5. Critical void-ratio of fine sand (sand A) is practically independent of vertical loading.

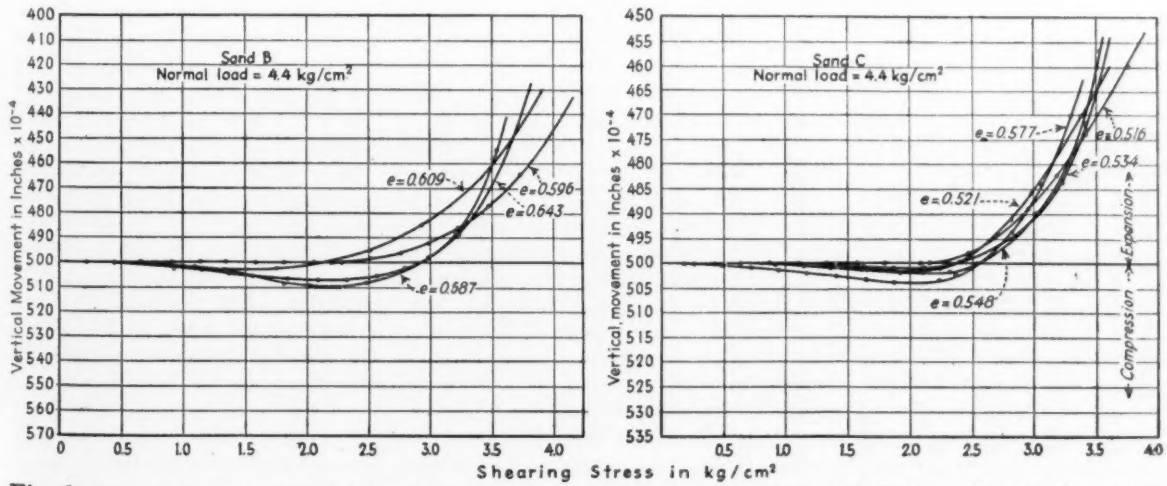


Fig. 6. For sand B (left) and sand C (right) the critical void-ratios are lower than for sand A; better grading gives lower ratio.

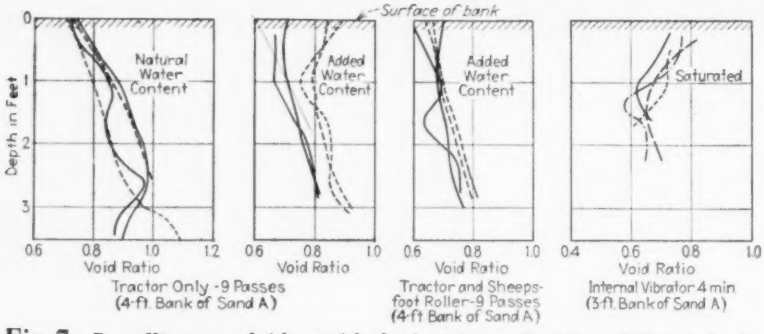

Depth in Feet
Natural Water Content
Added Water Content
Surface of bank
Added Water Content
Saturated
Void Ratio
Tractor Only - 9 Passes (4-ft. Bank of Sand A)
Tractor and Sheepsfoot Roller-9 Passes (4-ft Bank of Sand A)
Internal Vibrator 4 min (3-ft. Bank of Sand A)

Fig. 7. **By rolling top of 4-ft. or 3-ft. bank and sampling from different depths, the penetration of the compacting action was explored, to guide choice of layer thickness.**

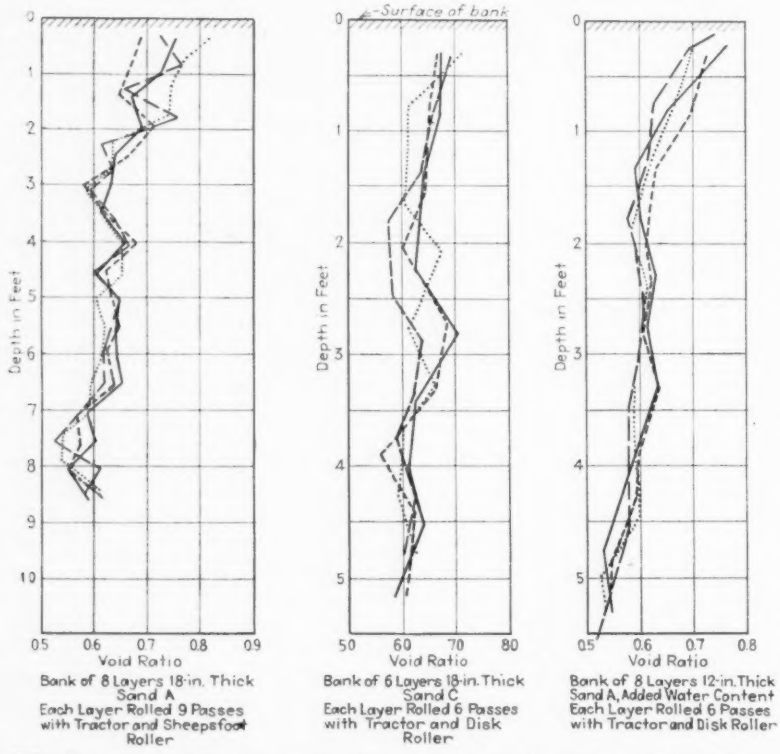

Depth in Feet
Surface of bank
Void Ratio
Bank of 8 Layers 18-in. Thick Sand A Each Layer Rolled 9 Passes with Tractor and Sheepsfoot Roller
Bank of 6 Layers 18-in. Thick Sand C Each Layer Rolled 6 Passes with Tractor and Disk Roller
Bank of 8 Layers 12-in. Thick Sand A, Added Water Content Each Layer Rolled 6 Passes with Tractor and Disk Roller

Fig. 8. **Three Test Banks placed and rolled in layers showed that satisfactory compaction can be obtained. Middle curve shows insufficient compaction with sand C; right-hand curve shows 12-in. layers compacted more uniformly than the 18-in. layers of left-hand curve.**

the lower the critical void ratio. Material C is also represented in Fig. 6. In preparing the samples for critical density tests, the dry material was reduced to as low a void ratio in the shear box as practicable by systematic tapping and tamping.

Field test

It was realized at the start that cohesionless materials would not respond to compaction in the same manner as cohesive soils. A series of tests was first run with the fine sand and silt mixture loosely built up in banks 4 ft. high, over which various types of compacting equipment were run. It was particularly desired to use available standard equipment with which contractors are familiar, in determining which types of equipment could develop the required densities. This was decided upon after considering the various machines for vibrating cohesionless materials as developed in Germany.

The value of a crawler tractor for compaction of this material, due to its weight and vibration, was demonstrated, and in addition thereto a sheepsfoot roller and a disk roller gave acceptable results. For the purpose of the tests, control was based on the number of passages of the tractor treads over the surface. One pass required that the tractor treads must cover the entire surface under test, regardless of the equipment drawn by the tractor. This was done to insure that all parts of the fill had been subject to the same amount of compaction by the heaviest unit of equipment. Other means of control were established for equipment not drawn by the tractor.

Effect of rolling

Fig. 7 shows the depth effect obtained with the tractor alone on the 4-ft.-high bank with natural borrow-pit water content. It also shows the depth effect of the tractor alone when the material was moistened to about 21 per cent water content and the depth effect obtained with the tractor and sheepsfoot roller at about 21 per cent water content. For these tests the banks were built up in the loosest possible condition. Fig. 7 shows at the right the results obtained on a saturated bank by use of an internal concrete vibrator.

The effect of compacting was transmitted to somewhat greater depths than are usually specified for layer thickness and it was decided to use an initial layer thickness of 18 in. for a series of tests. Fig. 8 (left) shows the results obtained with the tractor and sheepsfoot roller using 18-in. layers; however, the water content was not optimum. The decrease in the void-ratio values with depth is noticeable.

Fig. 8 (center) shows the results obtained with the tractor and disk roller using 18-in. layers with added water; this test was made on sand C. Compared with the critical density of material C as given by Fig. 6 (right) the result is not satisfactory. However, with 12-in. layers and optimum water content better results are expected.

Difficulty was experienced in obtaining the true water content at the time when the bank was built. In most cases, a test bank could not be sampled on the same day it was built, and on the following day the moisture was noticeably less.

Optimum water content was determined by the laboratory to be about 22 per cent by weight and in

practice was found to be just short of the saturation point. Operation of the equipment became impossible at the saturation point.

The void-ratio curves in Fig. 8 (left and center) present an irregular, sawtoothed line, which is due to the layer thickness being somewhat greater than can be compacted by the equipment. Later tests, as shown at the right in Fig. 8, overcame this by using 12-in. layers.

Vibration of the material in a saturated state was tried on a small scale, using an internal vibrator and a surface vibrator, each for a series of tests. It was recognized that with the large quantities of material going into a dam daily the use of such equipment would not be practicable, but the tests are interesting in the character of the results obtained. Results obtained with either type of vibrator are similar. Fig. 9 shows the compacted sample in section. Entrained air was collected by the process but remained in the mass in cells of globular form, producing a honeycombed effect. The density is satisfactory even considering the honeycombing, but the obvious danger exists that the material may later break down on becoming saturated in a dam.

Fig. 9. Lump of compacted sand was of satisfactory density but contained objectionable honeycombing produced by internal vibrator.

Conclusion

1. The tests developed satisfactory methods for use in compacting cohesionless materials A and B, and showed that the materials would be usable in the dam. A heavy crawler tractor followed by either a sheepsfoot or disk roller making 6 to 8 passes over the materials in layers 12 in. in thickness will produce a void ratio of about 0.60 at optimum moisture content, which is sufficiently low to satisfy the critical density requirement. It is believed that material C if placed in 12-in layers with optimum water content will show better results than found for 18 in. layers.

2. Moisture content is difficult to control, and samples taken some hours after rolling will not show the true moisture content used in building up the test bank.

3. Optimum moisture content being that content with which the material can be compacted to attain its maximum weight, it can be taken, in this case, as the moisture content nearest saturation that will permit the operation of compacting equipment thereon.

4. Sufficient tests have not yet been made to establish a relation between the void ratio of a cohesionless material and its critical density. Critical density does vary with the maximum attainable density, grading of the material and possibly with the size and shape of the grains. The analysis of stability of slopes should give consideration to the critical density of the material, as the angle of internal friction varies with the density of the material.

Personnel

The tests were carried out by the Flood Control Division, U. S. Engineer Corps, Boston District, Lt. Col. K. B. Lyman is district engineer; Capt. J. H. Stratton is chief of the engineering division, F. P. Fifer, chief of flood control division. The writer was directly in charge of the tests, with R. H. Trites, assistant engineer, directing the field work and R. M. Haines, assistant engineer, in charge of field laboratory testing.

Irrigation Work Affected by Bankruptcy Act

THE PAYMENT of construction costs, engineering fees, and the subsequent maintenance for irrigation districts formed under state laws and financed, as is customary, with funds received from the sale of the district's bonds may now come under the United States Bankruptcy Act, Chapter X, effective Aug. 16, 1937, according to a decision of the U. S. Supreme Court, April 25, 1938. This decision awarded the Lindsay-Strathmore Irrigation District, Calif. (United States v. Bekins: U. S. Sup. Ct. Docket No. 772 and 752; decided April 25, 1938), which has been in default and made a voluntary petition for a composition with its creditors under Chapter X, the right to determine its creditor claims and receive a final discharge as in the case of other corporations which have heretofore cleared their credit by bankruptcy procedure. The present Chapter X was carefully drawn by the judiciary committee of Congress in response to an emergency and the Supreme Court held that its provisions do not interfere with a state's control of its fiscal affairs. Chapter X applies only to "taxing agencies" of a state and not to "political subdivisions" which limit in Chapter IX (enacted in 1934) was found to be unconstitutional because interfering with a state's power of taxation (Ashton v. Cameron County, etc. (Tex.) 298 U. S. 513). Jurisdiction under Chapter X expires June 30, 1940. This amendment to the Bankruptcy Act should prove helpful in promptly discharging insolvent districts from creditor claims based on their ability to pay under some form of refunding plan.

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Oil, Not Water Power, Is Coal Competitor

ALTHOUGH it is true that coal is supplying a smaller proportion of the world's energy requirements than formerly, oil, rather than water power, is taking its place, according to statistics compiled by the International Labor Office for presentation to the World Coal Conference at Geneva this month.

In a comparison between the world's energy sources in 1935 and in 1913, the figures reveal that coal and lignite dropped from 74.1 to 60.3 per cent. In the same period oil jumped from 4.5 to 16.5 per cent and water power increased from 2.4 per cent to 6.6 per cent; natural gas also increased from 1.4 per cent to 3.8 per cent. Wood still supplied 12.8 per cent of the total energy used in 1935, but it had decreased from 17.6 since 1913.

Water Main Sterilization With Dry Chlorine Compounds

Methods used in two southern cities in treating new pipe lines before they are put in operation lead to development of an improved system

STERILIZATION of new watermains before they are placed into service is an essential health safeguard. Contamination of pipe interiors during construction operations is a frequent occurrence.

A common and effective method of sterilization is to introduce in the pipe chlorine-containing compounds (such as chlorinated lime and hypochlorite) which, in the presence of water, will liberate chlorine. If adequate contact time is permitted during which a residual chlorine dose is maintained, the pipe will be rendered sterile.

Adding the chemical

The procedure at Charleston, S. C., where all new mains are sterilized, is to add a predetermined amount of a dry chlorine compound to each piece of pipe at the joint end when it is laid. After the construction work is completed water is turned into the line, which is completely isolated from the distribution system by valves. After a week of "soaking" the line is emptied and is then ready for use, according to J. E. Gibson, manager and engineer of the Charleston Water Department.

Sufficient chemical is added in each case to provide a solution containing initially 50 p.p.m. of chlorine. In order that construction crews can handle this sterilizing operation as a routine part of the pipe laying procedure, each foreman carries a data card on which is noted the amount of chemical needed to give the proper dosage.

As shown in the accompanying tabulation, the card lists the various sizes of pipe along with the required amount of chemical required per 100 ft. of length; in addition, there is given the length of pipe sterilized by 1 oz. and by 6 oz. of chemical, respectively. The foreman is relieved, therefore, of making any but the simplest calculations.

The funnel method

Wilmington, N. C., also sterilizes new mains with a dry chlorine compound in a manner similar to that described. Recently, however, it has been decided to use a different method for introducing the chemical. After the pipe line is laid and closed off at one end, a 1-in. corporation cock will be inserted at the other end. A funnel will be inserted in the cock through which high test hypochlorite can be fed to the pipe.

The valve controlling entrance of water into the line will then be opened slightly and as water passes the corporation cock connection it will take into solution the chemical which is fed continuously in small amounts. When the pipe line is full of water it will be permitted to stand undisturbed for 6 hrs. after which it will be thoroughly flushed out.

M'Kean Maffitt, superintendent of water and sewers at Wilmington, feels that this method will insure more uniform distribution of the chlorine solution than the procedure in which a pre-determined measure of chemical is added at each joint during construction. His experience with the latter indicates that when water is first introduced it sweeps the chemical to one end of the pipe. This causes a heavy dosage of chlorine at one end but very little at the upper end where the water entered originally.

AMOUNTS OF CHLORINE COMPOUNDS REQUIRED FOR STERILIZING VARIOUS SIZES OF WATER MAINS (BASED ON DOSAGE OF 50 P.P.M.)

	Chlorinated Lime — 24% Chlorine			High Test Hypochlorite — 65% Chlorine		
Pipe Size Inside Dia.	Lb. Per 100 Ft.	Length per Oz.	Length Per 6 Oz.	Lb. Per 100 Ft.	Length Per Oz.	Length Per 6 Oz.
4 in.	0.1135	53 ft.	318 ft.	0.0419	144 ft.	.....
6 in.	0.256	24 ft.	144 ft.	0.0943	64 ft.	.....
8 in.	0.453	13 ft.	78 ft.	0.167	36 ft.	.....
10 in.	0.71	9 ft.	54 ft.	0.262	24 ft.	.....
12 in.	1.023	6 ft.	35 ft.	0.377	16 ft.	96 ft.
16 in.	1.818	.....	22 ft.	0.670	.....	60 ft.
20 in.	2.84	.....	13 ft.	1.05	.....	36 ft.
24 in.	4.09	.....	9 ft.	1.51	.....	24 ft.

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Many Cities Acquire Central Parking Lots

IN AN attempt to solve their growing parking and traffic congestion problems, cities in at least 17 states have acquired municipally-owned parking space near their central business districts, according to a survey conducted by the American Society of Planning Officials and the International City Managers' Association.

Twenty-five cities reported that they are providing off-street parking space, while six others announced surveys of their parking problem with a view toward establishing municipal parking lots. Virtually all of the cities maintaining municipal parking areas reported that business men in the city are favorable to the plan. Parking fees in the municipal lots range from 10 to 75 cents a day, with 25 cents the average fee for all-day parking. In most of the 200 cities surveyed, merchants and business firms provide at least partial parking facilities to their customers. San Diego, Calif., is among the cities providing a large free parking area, and Kansas City, Kan., has a bill pending in the legislature to enable condemnation of land for free parking in the business district.

The city of Chicago lake-front parking space in Grant Park, near the business district, is probably the largest municipal parking area in the nation. This area now has a capacity of 2,500 cars and is being enlarged to provide parking facilities for 3,500 cars within the next few months.

Laboratory Tests on Structural Plywood

HARRY A. WILLIAMS
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Strength determinations on thick Douglas fir plywood and plywood joints, with and without timber connectors, under various load conditions

ENGINEERS have recently been introduced to timber joints using gusset plates made of thick structural plywood with metal ring-dowel connectors. The designer has seen at once how plywood 4 in. or 6 in. thick can serve as gusset and spacer at the same time, with the added advantage that members can be connected to its edges as well as to its faces. However, the dearth of information about the physical properties of this special plywood and its properties when used in joints with or without metal connectors resulted in uncertainty which could be cleared up only by experimentation. Accordingly, a series of tests was made in the materials laboratory at Stanford University to determine strength values for Douglas fir plywood manufactured on the Pacific Coast. The investigation included compression, tension, shear, and flexure tests of the plywood, and strength tests of joints made of plywood and solid lumber using 2½-in. and 4-in. split-ring connectors.

Structural plywood, so called to distinguish it from ordinary commercial plywood, is designed to withstand stresses such as those occurring in structural frames. It is manufactured in the usual manner. That is, a log is steamed and placed in a lathe; as it revolves, knives peel off a continuous layer or sheet of wood usually ⅛ in. thick from the outside of the log. This sheet then is cut as required and panels are built up by gluing sheets together; successive sheets (plies) are laid with the grain at right angles and this is continued until the desired thickness is obtained. Intermediate plies are coated on both sides with a glue of soybean base and the panel is allowed to dry in a cold press.

The laboratory tests were made to determine the physical properties of structural plywood in compression, tension, shear, and flexure (Table I). Specimens were taken from standard stock having thicknesses of 1¾ in. (11 ply) to 6 in. (47 ply) and loads were applied parallel, at 45 deg. or 90 deg. to grain of the face plies.

Standard testing procedure was followed. Compression test specimens were varied in size to investigate the scale effect, but the length was always four times the least dimension. Tension tests were made on specimens with reduced middle section. Care was taken in clamping each piece in the jaws of the testing machine to see that there was no eccentricity which would involve bending stresses. Shear tests were made in a standard shear apparatus. For one series the shear surfaces were parallel to the plies, and either ⅜ or ½ in. back from the face of the specimen. These distances correspond respectively, to the 2½-in. and 4-in. diameter split-ring connector groove depths. For a second series, the load was applied so that the shear area was perpendicular to the plies and ½ in. back from the edge of the specimen.

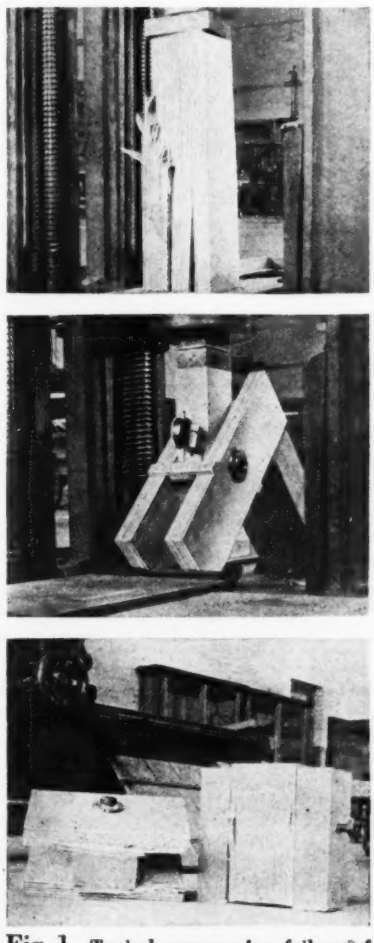

Fig. 1. Typical compression failure of a 6x6x24 in. Douglas fir plywood specimen (top). Type B joint in testing machine, and typical joint failure; Type A (0 deg.) and C (90 deg.).

Results of the tests

Results varied notably with the angle between the load and the grain of the face ply. In compression the strength at 45 deg. was roughly only one-fourth to one-half as great as at 0 deg. At 90 deg. it was about three-fourths as great, probably because the inside cross bands were slightly thinner than the plies in the other direction. When the load was parallel or perpendicular to the face-ply grain, the compression specimens failed by shearing across the plies (Fig. 1), the plane of shear making an angle of 30 to 45 deg. with the horizontal. The 45-deg. compression specimens failed by shearing along the grain of one set of plies. In some of the larger specimens half the plies sheared one way, while the other half sheared in the opposite direction, causing the specimen to twist.

No consistent difference appeared between large and small compression specimens, although the ultimate unit strength of 2x2x8-in. specimens was

about 15 per cent greater than that of 6x6x24-in. specimens from the same slab. Part of this difference might be ascribed to the difficulty in getting suitable ends on the larger specimens.

Tensile proportional limit values shown in Table I are somewhat higher than corresponding values in the compression tests. On the other hand, the modulus of elasticity is considerably lower in tension than in compression. The ultimate strength is higher in tension when the load is parallel or perpendicular to the face ply grain, but it is lower at 45 deg.

The results of tests for shear parallel to the plane of the plies show considerable variation, more failures taking place in the glued joints than in the plies. When the load was applied at an angle of 90 deg. or 0 deg. to the face-ply grain, a ply failure always occurred in a ply having its grain at right angles to the direction of loading, as might be expected. When the load was at 45 deg. to the face-ply grain, twice as many failures occurred in the glued joints as in the plies. The latter specimens were 30 to 40 per cent stronger in shear than the 0 and 90 deg. types. The glue manufacturer gave 220 lb. per sq.in. as the average ultimate strength of a dry glued joint of the type used; most of the glue failures developed appreciably higher strength, although a few fell slightly below.

The values for shear in a plane at 90 deg. to the plies, as distinguished from shear parallel to the plies, showed less variation and were from three to four times as large as those described above.

The flexure tests were too few in number to be given much weight, but results as recorded in Table I are indications of values to be expected. These tests show that for a given direction of face-ply grain it makes little different in the strength and stiffness whether the plies are horizontal or vertical.

Tests on joints

The major part of the program was devoted to tests of joints made with various combinations of structural plywood and split-ring connectors using one pair of split-ring connectors per joint. The object of these tests was to determine for the various

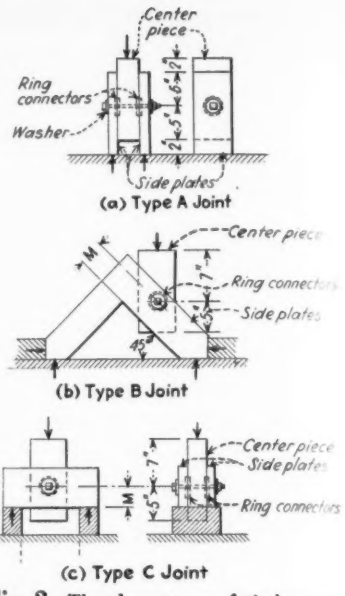

Fig. 2. The three types of timber connector joints on which tests were made.

TABLE I — STRENGTH PROPERTIES OF DOUGLAS FIR PLYWOOD

Type of Test	Angle of Load with Face Ply Grain	Number Specimens Tested	Proportional Limit 16/sq. in.		Ultimate Stress 16/sq. in.		Modulus of Elasticity Thousandth 16/sq. in.		Moisture Content % Dry Weight
			Range	Average	Range	Average	Range	Average	
	(Degrees)								
Compression	0	35	2950–4030	3620	3830–4560	4460	1040–1250	1210	9–14
	45	15	810–1070	955	1790–2185	2090	263– 345	321	
	90	15	2170–2880	2565	2960–3740	3345	718– 970	847	
Tension	0	10	3370–5170	4310	3910–5450	4940	997–1150	1100	10–11
	45	10	1030–1420	1300	1420–1780	1630	257– 290	276	
	90	11	3215–5040	3830	3620–5400	4300	689–1083	836	

Type of Test	Angle of Load with Face Ply Grain	Number Specimens Tested	Ultimate Stress lbs./sq. in.		Failures in Glued Joints			Failures in Plies			Moisture Content % Dry Weight
					No.	Ult. Stress (lbs./sq. in.)		No.	Ult. Stress (lbs./sq. in.)		
			Range	Average		Range	Average		Range	Average	
Shear on Plane Parrallel to Plies and 1/16 From Face of Specimen	0	22	245–540	370	10	270–515	365	11	245–540	360	9–12
	45	18	370–645	520	10	370–535	430	5	415–645	505	
	90	18	215–610	330	13	215–425	295	5	345–610	425	
Shear on Plane Parallel to Plies and 2 From Face of Specimen	0	24	215–595	370	10	215–595	395	12	265–400	370	
	45	24	340–645	470	14	340–645	470	7	460–530	495	
	90	24	240–520	395	12	240–520	390	12	250–515	400	
Shear on Plane Perpendicular to Plies and 1/2 From Edge of Specimen	0	18	1330–1880	1470							9–11
	45	14	1535–1850	1665							
	90	21	1340–1910	1625							

Type of Test	Angle of Load with Face Ply Grain	Number Specimens Tested	Proportional Limit lb./sq. in.		Modulus of Rupture lbs./sq. in.		Mod. of Elastic. in Bending — thous. lb./sq. in.		Moisture Content % Dry Weight
			Range	Average	Range	Average	Range	Average	
Flexure Plies Horizontal	0	5	2630–5200	4380	5100–11,400	8480	604–1370	1075	11–14
	45	4	1780–2190	1980	2020–3400	2780	306– 400	351	11–12
	90	5	2430–3410	3050	3350–7410	5230	427– 522	496	10–11
Flexure Plies Vertical	0	4	3350–4330	3960	6430–8000	7210	760–1230	1000	11
	45	4	1890–2560	2160	2590–3500	3020	218– 327	272	10–12
	90	4	2730–3900	3140	5240–7100	5780	610– 980	758	10–12

TABLE II — STRENGTH PROPERTIES OF PLYWOOD — SOLID LUMBER JOINTS MADE WITH SPLIT-RING CONNECTORS*

Test Series No.	Type of Joint (Fig. 3)	Diameter Connectors (inches)	Angle of Load With Face Ply Grain	Number Specimens Tested	Proportional Limit Load (pounds)		Ultimate Load (pounds)		Slip of Joint (inches)			Description of Joint		Distance M, Edge Margin, (inches)
					Range	Average	Range	Average	Non-elastic	Proportional Limit	Ultimate Strength	Side Plates	Center Piece	
			(degrees)									(dimensions in inches)		
1	A	2½	0	6	6500–7600	7070	17,310–20,090	18,780	.022–.030	.067–.081	0.6–1.0	Plywood 1⅜x3⅝x12	Solid lumber 2⅝x3⅝x12	
2	A	2½	0	6	5500–7500	6480	19,490–20,900	20,400	.020–.024	.060–.078	0.8–1.0	Solid lumber 1⅜x3⅝x12	Plywood 2⅝x3⅝x12	
3	A	2½	45	6	5300–7000	6160	15,350–16,200	15,740	.019–.024	.065–.083	1.0	Same as No. 1 except plywood cut 45 deg. to grain		
4	B	2½	45	7	6400–8200	7400	14,400–21,500	——	.017–.032	.084–.113	0.3–1.2	Plywood 1⅜x18	Same as No. 1	2¾ to 4¾
5	A	2½	90	6	5500–6700	6080	15,200–16,600	15,960	.025–.029	.070–.078	0.8–0.9	Same as No. 1 except plywood face ply grain parallel to short dimension of plate		
6	C	2½	90	19	5500–7900	6770	9,370–18,800	——	.016–.033	.070–.097	0.2–1.1	Plywood 1⅜x14 (6" clear span)	Same as No. 1	2¾ to 4¼
7	A	4	0	5	14,800–17,500	16,100	32,300–34,800	33,000	.024–.031	.073–.084	.04–.08	Plywood 1⅜x5½x12	Solid lumber 3¼x5½x12	
8	A	4	0	9	14,500–21,000	17,200	28,800–41,500	——	.015–.031	.067–.085	0.9–1.7	Solid lumber 3x5½x12	Plywood 6x12	
9	B	4	45	5	17,100–21,200	18,600	35,900–39,200	28,300	.014–.025	.077–.088	0.6–1.0	Plywood 1⅜x20	Solid lumber 3x5½x12	5¼ to 7
10	C	4	90	10	12,300–16,800	15,100	14,500–36,100	——	.026–.032	.083–.115	0.2–1.4	Plywood 1⅜x14 (8" clear span)	Solid lumber 3¼x5½x12	3¼ to 7¼

* Moisture content of plywood was between 10% and 15% (10–12% for all but a few series.)
* Moisture content of solid lumber was between 12% and 16%.

joint types the proportional limit, ultimate strength, and slip.

Typical test set-ups are indicated in Fig. 2. Two Ames dials were attached to each specimen in such a way that any rotation of the center piece could be compensated for by taking the average of the two dial readings. Readings were taken every one-hundredth inch up to a total slip of 0.2 in., then at every two one-hundredths up to 0.3 in., after which the dials were removed and the load recorded for every one-tenth inch of slip. The tests were made either in a 30,000-lb. or a 200,000-lb. testing machine. A head speed of 0.05 in. per min. was used until the dials were removed, and 0.1 in. per min. thereafter.

Three types of joints were tested, as indicated in Fig. 2, each made with a single pair of 2½-in. or 4-in. split-ring connectors and with pieces of a size ordinarily used in timber construction. The Douglas fir used throughout had an ultimate strength (in compression) of 7,000 to 8,000 lb. per sq.in., and a moisture range of 12 to 16 per cent. Preliminary tests of joints showed that the Douglas fir cores sheared after the plywood cores had given way.

Results of tests

Results of tests on joints are given in Table II. Since the bolts holding the joints together were merely drawn up snugly, little slip occurred until the bolt began to bend some time after the cores had sheared. Hence the non-elastic slip recorded in the table resulted from a load of only a few hundred pounds at the beginning of the test and indicates the slack in the joint. This might be of some importance in members subjected to reversal of stress.

The proportional limit was probably reached in all joints through a combination of core shear and bearing failure. Roughly speaking, the proportional limit was the same for all joints of a given connector size. Since plywood loaded at 45 deg. to the face-ply grain is weaker in compression and stronger in shear than when loaded at either 0 deg. or 90 deg. it is reasonable to expect that these factors compensate to give about the same proportional limit in joints regardless of the angle of loading. Some flexure stress on the core may be a factor here also.

After core failure, the metal connectors acted like solid dowels, although they usually crushed the confined cores and took an elliptical shape. As the ultimate load was approached, the crowding action of the connector frequently split the plywood out at the sides on the Type *A* joints, (Fig. 2). The specimens continued to take load, however, the increase depending on the width of the plywood. An attempt was made (Series No. 8) to obtain the relation between the load at which the splitting occurred and the width of the piece. The variation is shown in Table II. While the tests were insufficient in number to indicate a definite relationship, a straight-line variation might be assumed as an approximation pending further tests. Such information is of doubtful practical value in any event, since the ultimate load was not definitely determined by this factor in this type of joint.

The ultimate strength of both the Type *B* and *C* joints was limited largely by the shearing of the plywood under the connectors. If the test was continued until the total slip was about 1½ in., the load could sometimes be increased as much as 60 per cent. In Series 4, 6, and 10 the edge margin *M* was varied as described in the table. The load at which the plywood sheared under the connectors held roughly a straight-line relationship to the edge margin. If Series 3 and 5 are omitted as being less typical of actual construction, and provided suitable edge margins are used, the ultimate strength is roughly the same for all joints of each ring size.

In all the tests plywood and solid lumber were used in conjunction. In all cases except Series 2 and 8 (Table II) the plywood plates were on the outside and the center piece was the solid one. In Series 2 and 8 the positions were reversed, for com-

parative purposes; that is, the plywood was put inside, between two solid pieces. The results indicate that this change had little if any effect on the proportional limit but that the ultimate strength was increased; increase can be accounted for by the difference in the flexure strength of the plywood and solid lumber. The moment exerted on the side plates by the connectors resulted in a noticeable bending of the plywood as the ultimate load was approached.

Explanation of tables

For the compression tests in Table I the specimens were cut from three thicknesses of plywood, namely 11-ply, 1⅜ in. thick; 21-ply, 2⅝ in. thick and 47 ply, 6 in. thick. Three specimen sizes were used, ranging from 1⅜x1⅜x5½ in. to 6x6x24 in. These were tested at angles of 45 and 90 deg. Six sizes were tested under loads applied parallel to the grain of the outer plies. The number of specimens tested ranged from 3 to 7 in each size.

The tension test specimens (Table I) were cut from stock of the three thicknesses mentioned in the foregoing, with cross-sections reduced to about 1⅛x1¼ in. In these specimens the gage length was 8 in.

In the shear and flexure tests the specimens, cut from three different thicknesses of plywood, were made to correspond as closely as possible to the American Society of Testing Material's specification D 143-27 and the procedure there prescribed was followed. A few combination glue joint and ply failures occurred in the shear tests.

In the flexure tests (Table I) 11- and 47-ply stock was used; one-half the specimens were cut from each thickness.

In test 8 (Table II), width of the plywood center piece varied from 5½ to 7½ in. The ultimate load given in the table (not the actual ultimate) was taken as that value at which crowding action of the connector sheared out the plywood at the edges of the piece. Thereafter, further loading was applied up to an average of 40,000 lb. for four joints so tested.

In test 9 three additional joint tests, not recorded, with plywood having a moisture content of 16 per cent, gave results 10 per cent lower.

In test 10, for slips in excess of 1.5 in. the ultimate loads varied from 23,400 (for *M* equal to 3¼ in.) to 37,000 lb. (for *M* equal 7¼ in.).

Conclusions

In planning the tests it seemed desirable to cover a rather extensive field, although the program was limited to Douglas fir plywood supplied by one manufacturer. While the results are a fair indication of the properties of this plywood, they should be considered as tentative and subject to modification when similar information is available for other plywood assemblies. Hence, the following conclusions are limited to the results of this program and are not of a general nature:

1. The plywood was much weaker in both tension and compression when loaded at 45 deg. than when loaded parallel to the face ply grain. It was somewhat weaker at 90 deg. primarily because the cross plies were not as thick as the vertical plies. This condition could be changed by the manufacturer. In thin panels, the difference in the number of cross plies and vertical plies would be a larger factor.

2. In shear in a plane parallel to the plies, the plywood was about equally strong when loaded at 0 deg. and 90 deg. to the face-ply grain, but both strengths were less than the 45 deg. value. A majority of the failures occurred in the glue joints rather than in the plies. For shear in a plane perpendicular to the plies, the plywood was almost equally strong for all angles of loading and was from 3 to 4 times as strong as for shear in planes parallel to the plies.

3. The few flexure tests indicated little difference in strength between a beam in which the plies are horizontal and one in which they are vertical. The beams were somewhat weaker under 90-deg. loading and considerably weaker under 45 deg. loading than when the face-ply grain was parallel to the long dimension of the specimen.

4. For a given ring size, the Douglas fir plywood joints with split-ring connectors were roughly of equal strength regardless of the angle between the load and the face-ply grain.

5. In determining working stresses for plywood and working loads for joints of the type tested, most weight should be given to the proportional limit value. Over a long period of time, wood fails at loads somewhat in excess of the proportional limit and considerably below the ultimate strength as determined in laboratory tests. A few constant load tests made by the writer indicate that joints will not sustain a so-called ultimate load for any length of time. Moreover, in selecting factors of safety, attention should be given to minimum as well as to average values obtained from tests.

The tests described in the foregoing were conducted in the materials laboratory at Stanford University under the direction of the writer and in cooperation with the Timber Engineering Co. of California and the Harbor Plywood Co.

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Federal Irrigation Projects Expect Good Year

A GOOD WATER YEAR for the irrigated sections of the West has been forecast in a report by John C. Page, Commissioner of the U. S. Bureau of Reclamation. While the season for storage of irrigation water is not yet over, a total of 26,023,877 acre-ft. already has been caught and held for use by irrigators during the coming dry summer season. This represents an increase of 6,397,860 acre-ft. over the total stored in the reclamation reservoirs at this time last year.

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Uncertain Money Conditions Affect Mexican Road Work

STRINGENT REDUCTIONS in appropriations for both highway and railway construction, is reported from Mexico, in line with the general governmental economies following the upheaval due to the expropriation of the oil companies, the unstable peso exchange and the restriction of credit. Appropriations for highway construction for 1937 were 28,830,000 pesos ($8,000,000 but that figure will have to be drastically cut for this year, to effect economies in both personnel and material. No road building machinery will be purchased this year by the Mexican government, which has cut the road building budget to 20,670,000 pesos ($5,700,000), plus 11,000,000 pesos for federal expenditures in cooperation with the states.

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